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ON THE EVOLUTION OF THE FAMILY.

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I.

LET us now look at the connections between types of family and social types. Do societies of different degrees of composition habitually present different forms of domestic arrangement? Are different forms of domestic arrangement associated with the militant system of organization and the industrial system of organization?

To the first of these questions, no satisfactory answer can be given. The same marital relation occurs in the simplest groups and in the most compound groups. A strict monogamy is observed by the miserable Wood Veddahs, living so widely scattered that they can scarcely be said to have reached the social state; and the wandering Bushmen, similarly low, though not debarred polygyny, are usually monogamic. Certain settled and slightly advanced tribes, too, are monogamic; as instance the New Guinea people, and as instance also the Dyaks, who have reached a stage passing from simple into compound. And then we have monogamy habitual with nations which have become vast by aggregation and reaggregation. Polyandry, again, is not restricted to societies of one order of composition. We find it in simple groups, as among the Fuegians, the Aleutians, and the Todas; and we find it in compound groups in Ceylon, in Malabar, in Thibet. Similarly with the distribution of polygyny. It is common to simple, compound, doubly-compound, and even trebly-compound societies.

One kind of connection between the type of family and the degree of social composition may, however, be alleged. Formation of compound groups, implying greater coördination and the strengthening of restraints, implies more settled arrangements, public and private.

Increasing rigidity of custom and growth of it into law, which goes along with the extending governmental organization holding larger masses together, affects the domestic relations along with the political relations; and thus renders the family arrangements, be they polyandric, polygynic, or monogamic, more definite.

Can we, then, allege special connections between the different types of family and the different social types classed as militant and industrial? None are revealed by a cursory inspection. Looking first at simple tribes, we find among the unwarlike Todas a mixed polyandry and polygyny; and among the Esquimaux, so peaceful as not even to understand the meaning of war, we find, along with monogamic unions, others that are polyandric and polygynic. At the same time, the warlike Caribs show us a certain amount of polyandry and a greater amount of polygyny. If, turning to the other extreme, we compare with one another large nations, ancient and modern, it seems that the militant character in some cases coexists with a prevalent polygyny and in other cases with a prevalent or universal monogamy. Nevertheless, we shall, on examining the facts more closely, discern general connections between the militant type and polygyny, and between the industrial type and monogamy.

But first we must recognize the truth that a predominant militancy is not so much to be measured by armies and the conquests they achieve, as by constancy of predatory activities. The contrast between the militant and the industrial is properly between a state in which life is occupied in conflict with other beings, brute and human, and a state in which life is occupied in peaceful labor—energies spent in destruction instead of energies spent in production. So conceiving militancy, we find polygyny to be its habitual accompaniment. To trace the coexistence of the two from Australians and Tasmanians on through the more developed simple societies up to the compound and doubly compound, would be tedious and is needless; for observing, as we have already done, the prevalence of polygyny in the less advanced societies, and admitting as we must their state of unceasing hostility to their neighbors, the coexistence of these traits is a corollary. That this coexistence results from causal connection is suggested by certain converse cases. Among the Dorians, a division of the New Guinea people, there is strict monogamy, with forbidding of divorce, in a primitive community comparatively unwarlike and comparatively industrial. Another instance is furnished by the Land Dyaks, who are monogamic to the extent that pologyny is an offense, and who, though given to tribal quarrels about their lands, and to the taking of heads as trophies, have such degree of industrial development that the men, instead of making war and the chase habitual occupations, do all the heavy work, and some division of trades and commercial intercourse exists. The Hill-tribes of India furnish other instances. There are the amiable Bodo and Dhimals, without military arrange-

ments, and having no weapons but their agricultural inplements, who are industrially advanced to the extent that there is exchange of services, and that the men do all the out-of-door work; and they are monogamous. Similarly the monogamous Lepchas are wholly unwarlike. Such, too, is the relation of traits in certain societies of the New World distinguished from the rest by being partially or entirely industrial. Whereas most of the aborigines of North America, habitually polygynous, live solely to hunt and fight, the Iroquois had permanent villages and cultivated lands, and each of them had but one wife. More marked still is the case of the Pueblos, who, "walling out barbarism" by their ingeniously-conglomerated houses, fight only in self-defense, and when let alone engage exclusively in agricultural and other industries, and whose marital relations are strictly monogamic.

This connection of traits in the simpler societies, where not traceable directly in the inadequate descriptions of travelers, is often traceable indirectly. We have seen that there is a natural relation between constant fighting and development of chiefly power: the implication being that where, in settled tribes, the chiefly power is small, the militancy is not great. And this is the fact in those above-named communities characterized by monogamy. In Dory there are no chiefs; among the Dyaks subordination to chiefs is feeble; the headman of each Bodo and Dhimals village has but nominal authority; the Lepcha flees from coercion; and the governor of a Pueblo town is annually elected. Conversely, we see that the polygyny which prevails in simple predatory tribes persists in aggregates of them welded together by war into small nations under established rulers, and frequently acquires in them large extensions. In Polynesia it characterizes in a marked way the warlike and tyrannically-governed Feejeeans; all through the African kingdoms there goes polygyny along with developed chieftainship, rising to great heights in Ashantee and Dahomey, where the governments are coercive in extreme degrees. The like may be said of the extinct American societies: polygyny was an attribute of dignity among the rigorously-ruled Peruvians, Mexicans, Chibchas, Nicaraguans. And the old despotisms of the East were also characterized by polygyny.

Allied with this evidence is the evidence that in a primitive predatory tribe, all the men of which are warriors, polygyny is generally diffused; but in a society compounded of such tribes, polygyny continues to characterize the militant part, while monogamy begins to characterize the industrial part. This differentiation is foreshadowed even in the primitive predatory tribes; since the least militant men fail to obtain more than one wife each. And it becomes marked when, in the growing population, there arises a division between warriors and workers.

Still more clearly shall we see the connection between militancy

and polygyny on recalling two facts named in the chapter on "Exogamy and Endogamy." By members of savage communities, captured women are habitually taken as additional wives or concubines, and the reputations of warriors are enhanced in proportion to the numbers thus obtained. As Mr. McLennan points out, certain early peoples permitted foreign wives (presumably along with other wives) to the military class, when wives from alien societies were forbidden to other classes. Even among the Hebrews the laws authorized such appropriations of women taken in war. The further direct connection is, that where loss of many men in frequent battles leaves a great surplus of women, the possession of more wives than one by each man conduces to the maintenance of population and the preservation of the society: continuance of polygyny being, under these circumstances, insured by the conflicts between such societies, which, other things equal, entail the disappearance of those not practising it. To which must be added the converse fact that, in proportion as decreasing militancy and increasing industrialness cause an approximate equalization of the sexes in numbers, there results a growing resistance to polygyny; since it cannot be practised by many of the men without leaving many of the rest wifeless, and causing an antagonism inconsistent with social stability. Hence monogamy is to a great extent compelled by that balance of the sexes which industrialism brings about.

Once more, the natural relation between polygyny and predominant militancy, and between monogamy and predominant industrialness, is shown by the fact that these two domestic forms harmonize in principle with the two associated political forms. We have seen that the militant type of social structure is based on the principle of compulsory coöperation, while the industrial type of social structure is based on the principle of voluntary coöperation. Now, it is clear that plurality of wives, whether the wives are captured in war or purchased from their fathers regardless of their own wills, implies domestic rule of the compulsory type: the husband is despot and the wives are slaves. Conversely, the establishment of monogamy where fewer women are taken in war and fewer men lost in war is accompanied by an increased value of the individual woman, who, even when purchased, is therefore likely to be better treated. And when, with further advance, some power of choice is acquired by the woman, there is an approach to that voluntary coöperation which characterizes this marital relation in its highest form. The domestic despotism which polygyny involves is congruous with the political despotism proper to predominant militancy; and the diminishing political coercion which naturally follows development of the industrial type is congruous with the diminishing domestic coercion which naturally follows the accompanying development of monogamy.

Probably the histories of European peoples will be cited in evi-

dence against this view: the allegation being that, from Greek and Roman times downward, these peoples, though militant, have been monogamic. It may, however, be replied that ancient European societies, though often engaged in wars, had large parts of their populations otherwise engaged, and had industrial systems characterized by considerable division of labor and commercial intercourse. Further, there must be remembered the fact that in Northern Europe, during and after Roman times, while warfare was constant, monogamy was not universal. Tacitus admits the occurrence of polygyny among the German chiefs. Already we have seen, too, that the Merovingian kings were polygamists. Even in the Carlovingian period we read that—

"The confidence of Conan II. was kept up by the incredible number of men-at-arms which his kingdom furnished; for you must know that here, besides that the kingdom is extensive as well, each warrior will beget fifty, since, bound by the laws neither of decency nor of religion, each has ten wives or more even."—(Ermold. Nigellus, iii., *ap. Scr. R. Fr.*, vi., 52.)

And Kœnigswarter says that "such was the persistence of legal concubinage in the customs af the people that traces of it are found at Toulouse even in the thirteenth century."

Thus considering the many factors that have coöperated in modifying marital arrangements—considering also that some societies, becoming relatively peaceful, have long retained in large measure the structures acquired during previous greater militancy, while other societies which have considerably developed their industrial structures have again become predominantly militant, causing mixtures of traits—the alleged relations are, I think, as clear as can be expected. That advance from the primitive predatory type to the highest industrial type has gone along with advance from prevalent polygny to exclusive monogamy, is unquestionable; and that decrease of militancy and increase of industrialness have been the essential cause of this change in the type of family, is shown by the fact that this change has occurred where such other supposable causes as culture, religious creed, etc., have not come into play.

The domestic relations, thus far dealt with mainly under their private aspects, have now to be dealt with under their public aspects. For, on the structure of the family, considered as a component of a society, depend various social phenomena.

The multitudinous facts grouped in foregoing chapters show that no true conception of the higher types of family, in their relations to the higher social types, can be obtained without previous study of the lower types of family in their relations to the lower social types. In this case, as in all other cases, error results when conclusions are drawn from the more complex products of evolution, in ignorance

of the simpler products from which they have been derived. Already an instance has been furnished by the interpretations of primitive religions given by the reigning school of mythologists. Possessed by the ideas which civilization has evolved, and looking back on the ideas which prevailed among the progenitors of the civilized races, they have used the more complex to interpret the less complex; and when forced to recognize the entire unlikeness between the inferred early religious ideas and the religious ideas found among the uncivilized who now exist, have assumed a fundamental difference in mode of action between the minds of the superior races and the minds of the inferior races: classing with the inferior, in pursuance of this assumption, certain ancient races to which the modern world is indebted for its present advance. Though to the teachings of so-called Turanians the Aryans and Semites owe their civilizations; though the Accadians had great cities, settled laws, advanced industries, arts in which four metals were utilized, and writing that had already reached the phonetic stage, while the Semites were still nomadic hordes; though the Egyptians had for some thousands of years lived as an elaborately-organized nation, approaching in many of its appliances to modern nations, and producing monuments that remain a wonder to mankind, while the Aryans were wandering with their herds in scattered groups about the Hindoo Koosh—yet these peoples are, in company with the lowest barbarians, cavalierly grouped as having radically inferior intelligences, because they show in an unmistakable way the genesis of religious ideas irreconcilable with that genesis which mythologists are led by their method to ascribe to the superior races.

All who accept the conclusions set forth in the first part of this work, will see in this instance the misinterpretation caused by analysis of the phenomena from above downward, instead of synthesis of them from below upward. They will see that in search of explanations we must go below the stage at which men had learned to domesticate cattle and till the ground.

I make these remarks by way of introduction to a criticism on the doctrines of Sir Henry Maine. While valuing his works, and accepting as true within limits the views he sets forth respecting the family under its developed form, and respecting the part played by it in the evolution of European nations, it is possible to dissent from his assumptions concerning the earliest social stages, and from the derived conceptions.

As leading to error, Sir Henry Maine censures "the lofty contempt which a civilized people entertains for barbarous neighbors," which, he says, "has caused a remarkable negligence in observing them." But he has not himself wholly escaped from the effects of this sentiment. While valuing the evidence furnished by barbarous peoples

belonging to higher types, and while in some cases citing confirmatory evidence furnished by certain barbarous peoples of lower types, he has practically disregarded the great mass of the uncivilized, and ignored the vast array of facts they present at variance with his theory. Though criticisms have led him somewhat to qualify the sweeping generalizations set forth in his "Ancient Law;" though, in the preface to its later editions, he refers to his subsequent work on "Village Communities" as indicating some qualifications—yet the qualifications are but small, and in great measure hypothetical. He makes light of such adverse evidence as Mr. McLennan and Sir John Lubbock give, on the ground that the part of it he deems most trustworthy is supplied by Indian Hill-tribes, which have, he thinks, been led into abnormal usages by the influences invading races have subjected them to. And, though in his "Early Institutions" he goes so far as to say that "all branches of human society may or may not have been developed from joint families which arose out of an original patriarchal cell," he clearly, by this form of expression, declines to admit that in many cases they have *not* been thus developed.

He rightly blames earlier writers for not exploring a sufficiently wide area of induction. But he has himself not made the area of induction wide enough; and that substitution of hypothesis for observed fact which he ascribes to his predecessors is, as a consequence, observable in his own work. Respecting the evidence available for framing generalizations, he says:

> "The rudiments of the social state, so far as they are known to us at all, are known through testimony of three sorts—accounts by contemporary observers of civilizations less advanced than their own, the records which particular races have preserved concerning their primitive history, and ancient law."

And since, as exemplifying the "accounts by contemporary observers of civilizations less advanced than their own," he names the account Tacitus gives of the Germans, and does not name the accounts modern travelers give of uncivilized races at large, he clearly does not include as evidence the statements made by these.[1] Let me name here two instances of the way in which this limitation leads to the substitution of hypothesis for observation.

Assuming that the patriarchal state is the earliest, Sir Henry Maine says that "the implicit obedience of rude men to their parent

[1] He does, indeed, at page 17 of his "Village Communities," deliberately discredit this evidence—speaking of it as "the slippery testimony concerning savages which is gathered from travelers' tales." I am aware that, in the eyes of most, antiquity gives sacredness to testimony; and that so what were "travelers' tales" when they were written in Roman days have come, in our days, to be regarded as of higher authority than like tales written by recent or living travelers. I see, however, no reason to ascribe to Tacitus a trustworthiness which I do not ascribe to modern explorers, many of them scientifically educated—Barrow, Barth, Galton, Burton, Livingstone, Seeman, Darwin, Wallace, Humboldt, Burckhardt, and others too numerous to set down.

is doubtless a primary fact." Now, though among lower races, sons, while young, may be subordinate, from lack of ability to resist, yet that they remain subordinate when they become men cannot be asserted as a uniform, and therefore as a primary, fact. In a former paragraph it will be seen that obedience does not characterize all types of men. When we read that the Mantra "lives as if there were no other person in the world but himself;" that the Carib "is impatient under the least infringement" of his independence; that the Mapuché "brooks no command;" that the Brazilian Indian begins to display "impatience of all restraint at puberty"—we cannot conclude that filial submission is an original trait. When we find that, by many savages, parents, when they become burdensome in age, are killed or left to starve; that by some, as the Gullinomeros, "old people are treated with contumely, both men and women;" and that by other savages boys are not corrected for fear of destroying their spirit—we cannot suppose that subjection of adult sons to their fathers characterizes all types of men. When from Bancroft we learn that to the Navajos of North America, "born and bred with the idea of perfect personal freedom, all restraint is unendurable," and that among them "every father holds undisputed sway over his children until the age of puberty;" when we learn that, among some Californians, children after puberty "were subject only to the chief;" that among the Lower-Californians, "as soon as children are able to get food for themselves, they are left to their own devices;" and that among the Comanches male children "are even privileged to rebel against their parents, who are not entitled to chastise them but by consent of the tribe"—we are shown that in some races the parental and filial relation early comes to an end. So far from supposing that filial obedience is innate, and the patriarchal type a natural consequence, the evidence points rather to the inference that the two have evolved hand-in-hand under favoring conditions.

Again, referring to the way in which originally common ancestral origin was the only ground for united social action, Sir Henry Maine says:

> "Of this we may at least be certain, that all ancient societies regarded themselves as having proceeded from one original stock, and even labored under an incapacity for comprehending any reason except this for their holding together in political union. The history of political ideas begins, in fact, with the assumption that kinship in blood is the sole possible ground of community in political functions."

Now, if by "ancient societies" are meant those only of which records have come down to us, and if the "history of political ideas" is to include only the ideas of such societies, this may be true; but if we are to take account of societies more archaic than these, and to include under political ideas those of other peoples than Aryans and

Semites, it cannot be sustained. Proof has been given that political coöperation and the accompanying structures arise from the conflicts of social groups with one another. We have seen that this evolves chieftainship, which becomes established when the military activity is constant; and we have seen that, having first politically organized simple groups, this process afterward politically organizes compound groups, and again doubly-compound groups. Though it may be facilitated where "the commonwealth is a collection of persons united by a common descent from the progenitor of an original family," yet, in multitudinous cases, it takes place where no connection of this kind exists among the persons. The members of an Australian tribe which, under a temporary chief, join in battle against those of another tribe, have not a common descent, but are alien in blood. If it be said that political functions can in this case scarcely be alleged, then take the case of the Creeks of North America, whose men have various totems implying various ancestries, and whose twenty thousand people, living in seventy villages, have nevertheless evolved for themselves a government of considerable complexity. Or, still better, take the Iroquois, who, similar in their formation of tribes out of intermingled clans of different stocks, were welded by combined action in war into a league of five (afterward six) nations under a permanent republican government. Indeed, this system of kinship puts relations in political antagonism; so that, as we read in Bancroft of the Kutchins, "there can never be intertribal war without ranging fathers and sons against each other." Even apart from the results of mixed clanships, that instability, which we have seen characterized primitive relations of the sexes, negatives the belief that political coöperation everywhere originates from family coöperation. Instance the above-named Creeks, of whom, according to Schoolcraft, "a large portion of the old and middle-aged men, by frequently changing, have had many different wives, and their children, scattered around the country, are unknown to them."

Thus finding reason to suspect that Sir Henry Maine's theory of the family is not applicable to all human societies, let us proceed to consider it more closely:

He implies that, in the earliest stages, there were definite marital relations. That which he calls "the infancy of society"—"the situation in which mankind disclose themselves at the dawn of their history"—is a situation in which "'every one exercises jurisdiction over his wives and his children, and they pay no regard to one another.'" But in foregoing chapters on "The Primitive Relations of the Sexes," on "Promiscuity," and on "Polyandry," numerous facts have been given, showing that definite, coherent marital relations are preceded by indefinite, incoherent ones; and also that, among the marital relations evolving out of these, there are in many places types of family

composed not of a man with wife and children, but of a wife with men and children—such family-forms being found not alone in societies of embryonic and of infantine types, but also in considerably advanced societies.

A further assumption is that descent has always and everywhere been in the male line. That it has from the earliest recorded times of those peoples with whom Sir Henry Maine deals, must be admitted; and it may be admitted that male descent occurs also among some rude peoples of other types, as the Kukis of India, the Beloochees, the New-Zealanders, the Hottentots. It is by no means the rule, however, among the uncivilized. Mr. McLennan, who has pointed out the incongruity between this assumption and a great mass of evidence, shows that in all parts of the world descent in the female line prevails; and the abundant proofs given by him I might, were it needful, enforce by many others. This system is not limited to groups so little organized that they might be set aside as preinfantine (were that permissible); nor to groups that stand on a level with the patriarchal, or so-called infantine, societies in point of organization; but it occurs in groups, or rather nations, that have evolved complex structures. Ellis says that kinship was through females in the two higher ranks of the Tahitians; and Erskine says the like of the Tongans. It was so, according to Piedrahita, with the ancient Chibchas, who had made no insignificant strides in civilization. Among the Iroquois, again, "titles, as well as property, descended in the female line, and were hereditary in the tribe; the son could never succeed to his father's title of sachem, nor inherit even his tomahawk;" and these Iroquois had advanced far beyond the infantine stage—were governed by a representative assembly of fifty sachems, had a separate military organization, a separate ecclesiastical organization, definite laws, cultivated lands individually possessed, permanent fortified villages. So, too, in Africa, succession to rank and property follows the female line among the coast-negroes, inland-negroes, Congo people, etc., who have distinct industrial systems, four and five gradations in rank, settled agricultures, considerable commerce, towns in streets. How misleading is the limited observation of societies, is shown by Marsden's remark respecting the Sumatrans of the Batta district, that "the succession to the chiefships does not go, in the first instance, to the son of the deceased, but to the nephew by a sister;" and that "the same extraordinary rule, with respect to property in general, prevails also among the Malays of that part of the island:" the rule which he thus characterizes as "extraordinary" being really, among the uncivilized and little civilized, the ordinary rule.

Again, Sir Henry Maine postulates the existence of government from the beginning—patriarchal authority over wife, children, slaves, and all who are included in the primitive social group. But those who have read preceding chapters on "The Regulating System" and

"Social Types" will scarcely need reminding that in various parts of the world we find social groups without heads, as the Fuegians, some Australians, most Esquimaux, the Arafuras, the Land Dyaks of the Upper Sarawak River; others with headships that are but occasional, as Tasmanians, some Australians, some Caribs, some Uaupés; and many others with vague and unstable headships, as the Andamanese, Abipones, Snakes, Chippewyans, Chinooks, Chippeways, some Kamtchatdales, Guiana tribes, Mandans, Coroados, New Guinea people, Tannese. Though it is true that in some of these cases the communities are of the lowest, I see no adequate reason for excluding them from our conception of "the infancy of society." And even saying nothing of these, we cannot regard as lower than infantine in their stages those communities which, like the Upper Sarawak Dyaks, the Arafuras, the New Guinea people, carry on their peaceful lives without other government than that of public opinion and custom. Moreover, as has been pointed out, what headship exists in many simple groups is not patriarchal. Such chieftainship as arose among the Tasmanians in time of war was determined by personal fitness. So, too, according to Edwards, with the Caribs, and, according to Swan, with the Creeks. Then, still further showing that political authority does not always begin with patriarchal authority, we have the Iroquois, whose system of kinship negatives the genesis of patriarchs, and who yet have developed a complex republican government; and we have the Pueblos, who, living in well-organized communities under elected governors and councils, show no signs of patriarchal rule in the past.

Another component of the doctrine is that, originally, property is held by the family as a corporate body. According to Sir Henry Maine, "one peculiarity invariably distinguishing the infancy of society" is that "men are regarded and treated not as individuals but always as members of the particular group." The man was not "regarded as himself, as a distinct individual. His individuality was swallowed up in his family." And this alleged primitive submergence of the individual affects even the absolute ruler of the group. "Though the patriarch, for we must not yet call him the paterfamilias, had rights thus extensive, it is impossible to doubt that he lay under an equal amplitude of obligations. If he governed the family it was for its behoof. If he was lord of its possessions, he held them as trustee for his children and kindred . . . the family, in fact, was a corporation; and he was its representative." Here, after expressing the doubt whether there can exist in the primitive mind ideas so abstract as those of trusteeship and representation, I go on to remark that this hypothesis involves a conception difficult to frame. For while the patriarch is said to hold his possessions "in a representative rather than a proprietary character," he is said to have unqualified dominion over children, as over slaves, extending to life

and death; which implies that though he possesses the greater right of owning subordinate individuals absolutely, he does not possess the smaller right of owning absolutely the property used by them and himself. I may add that besides being difficult to frame, this conception is not easily reconcilable with Sir Henry Maine's description of the *patria potestas* of the Romans, which he says is "our type of the primeval paternal authority," and of which he remarks that while, during its decline, the father's power over the son's *person* became nominal, his "rights over the son's *property* were always exercised without scruple." And I may also name its seeming incongruity with the fact that political rulers who have absolute powers of life and death over their subjects, are usually also regarded as in theory owners of their property: instance at the present time the kings of Dahomey, Ashantee, Congo, Cayor on the Gold Coast. Passing to the essential question, however, I find myself here at issue not with Sir Henry Maine only, but also with those writers on primitive social states who hold that all ownership is originally tribal, that family ownership comes afterward, and individual ownership last. As already implied, the evidence appears to me to show that from the beginning there has been individual ownership of all such things as could without difficulty be appropriated. True though it is that in early stages rights of property have not acquired definiteness; certain though it may be that among primitive men the moral sanction which property equitably obtained has among ourselves is lacking; obvious as we find it that possession is often established by right of the strongest—the evidence implies that in the rudest communities there is a private holding of useful movables maintained by each man to the best of his ability. A personal monopoly extends itself to such things as can readily be monopolized—a proprietorship not yet made definite by the growth of social regulations. The Tinné, who, "regarding all property, including wives, as belonging to the strongest," show us in a typical way the primitive form of appropriation, also show us that this appropriation is completely personal, since they "burn with the deceased all his effects." Indeed, even apart from evidence, it seems to me an inadmissible supposition that in "the infancy of society" the egoistic savage, utterly without idea of justice or sense of responsibility, consciously held his belongings on behalf of those depending upon him.

One more element, indirectly if not directly involved in the doctrine of Sir Henry Maine, is that "the infancy of society" is characterized by the perpetual tutelage of women. While each male descendant has a capacity "to become himself the head of a new family and the root of a new set of parental powers," "a woman of course has no capacity of the kind, and no title accordingly to the liberation which it confers. There is therefore a peculiar contrivance of archaic jurisprudence for retaining her in the bondage of the family for life."

And the implication appears to be that this slavery of women, derived from the patriarchal state, and naturally accompanied by inability to hold property, has been slowly mitigated, and the right of private possession acquired, as the primitive family has decayed. But when we pass from the progenitors of the civilized races to existing uncivilized races, we meet with facts requiring us to qualify this proposition. Though in tribes of primitive men, knowing no law but that of brute force, entire subjection of women is the rule, yet there are exceptions, both in societies lower than the patriarchal in organization, and in higher societies which bear no traces of a past patriarchal state. We learn from Hodgson that among the Kocch, who are mainly governed by "juries of elders," "when a woman dies the family property goes to her daughters." Mason tells us of the Karens, whose chiefs, of little authority, are generally elective and often wanting, that "the father wills his property to his children. . . . Nothing is given to the widow, but she is entitled to the use of the property till her death." Writing of the Khasias, Lieutenant Steel says that "the house belongs to the woman; and in case of the husband dying or being separated from her, it remains her property." Among the Dyaks, whose law of inheritance is not that of primogeniture, and whose chieftainships where they exist are determined by merit, St. John tells us that as the wife does an equal share of work with her husband, "at a divorce she is entitled to half the wealth created by their mutual labors;" and Rajah Brooke writes, concerning certain Land Dyaks, that "the most powerful of the people in the place were two old ladies, who often told me that all the land and inhabitants belonged to them." North America furnishes kindred facts. Of the Aleutian-Islanders, Bancroft, in agreement with Bastian, tells us that "rich women are permitted to indulge in two husbands"—ownership of property by females being implied. Among the Nootkas, in case of divorce, there is "a strict division of property"—the wife taking both what she brought and what she has made; and similarly among the Jpokanes, "all household goods are considered the wife's property," and there is an equitable division of property on dissolution of marriage. Again, of the Iroquois, who, considerably advanced as we have seen, were shown, by their still-surviving system of descent in the female line, never to have passed through the patriarchal stage, we read that the proprietary rights of husband and wife remained distinct; and, further, that in case of separation the children went with the mother. Still more striking is the instance supplied by the peaceable, industrious, freely-governed Pueblos, whose women, otherwise occupying good positions, not only inherit property, but, in some cases, make exclusive claims to it. Africa, too, where the condition of women is in most respects low, but where descent in the female line continues, furnishes examples. Shabeeny tells us that in Timbuctoo a son's share of the father's property is double that of a daughter. Describing the cus-

toms of the people above the Yellala Falls on the Congo, Tuckey says fowls, eggs, manioc, and fruits, "seem all to belong to the women, the men never disposing of them without first consulting their wives, to whom the beads are given."

Thus there are many things at variance with the theory which sets out by assuming that "the infancy of society" is exhibited in the patriarchal group. As was implied in the chapters on the "Primitive Relations of the Sexes," on "Promiscuity," on "Polyandry," the earliest social groups were without domestic organization as they were without political organization. Instead of patriarchal cluster, at once family and rudimentary state, there was at first an aggregate of males and females without settled arrangements, and having no relations save those established by force and changed when the stronger willed.

OUR AMERICAN OWLS.

By Professor SAMUEL LOCKWOOD.

THE owls are rapacious birds, and in company with all the true birds of prey belong to the great order *Raptores*. The order branches into two large groups, known respectively as the diurnal and the nocturnal birds of prey. To the *Diurnes* belong the vultures, hawks, and eagles; to the *Nocturnes* belong the owls.

If Mrs. Malaprop cannot see why the owl is a "rapturous bird," she can admit its claim to openness of countenance. Once seen, the owl can never be mistaken; its flat, pussy face, and large, brassy cat-eyes, set square in front of the head, are so unbirdlike. It was a London holiday; a shop-woman and her daughter stood before the cage of Nocturnal Raptores at the "Zoo." Said the elder, "See these heagles!" to which the younger replied, "Them isn't heagles, they're 'awks." "If you please," interposed a servant standing near, "them isn't heagles nor 'awks, they're howls. My maister's son once kept one."

The owls are found nearly the whole world over. The books mention about two hundred species, as species are yet understood, and queer specimens are they every one. As a rule, how trim, spruce, compact, and graceful are the falcons, the typical birds of prey! How fluffy, squatty, and dowdyish is the typical owl! Whether it means little or much, it is thus with the Diurnal and the Nocturnal *Lepidoptera*. As the elder naturalist said: "If any analogy is allowable between different tribes of animals, the owls might be said to resemble moths" (the night-fliers), "and to differ from the diurnal birds of prey as these do from the butterflies" (the day-fliers). These birds

have been called "feathered cats," for the owl, cat-like, prowls at night, and steals upon its victim by a quick, fluffy, still swoop or spring. With the silent movements of a spirit, and a voice so supernatural, and with certain associations of time and place, the effect is appalling. As if burned into the brain-tissue with a hot iron, the memory of a certain night experience when but a lad is still fresh and vivid. It was a rural home; sickness had entered at "the witching-time of night." No man around, and the well must stay by the ill; then who should go for the doctor, more than a mile away? Impulsive and sympathetic, I was "the good and brave boy" to volunteer. Not until after midnight was the doctor's house reached, and he was out. Much disappointed that I must return alone, thinking to help the matter, I ventured upon that country-boy expedient known as a "short cut." So the open road was abandoned for a narrow path which led to the old graveyard, which having reached, my timidity began to increase. Cautiously I crossed the stile of the stone-wall, and just as I had entered, the clock in the old church-tower struck one! There was first a startling shock, then a prolonged horror, for the reverberations kept every fibre of my frame in a quivering thrill.

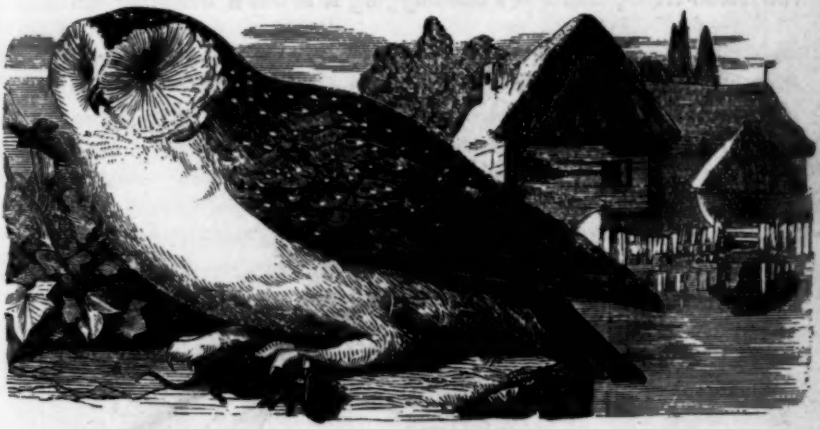

Fig. 1.—The White or Barn Owl of Europe (*Strix flammea*).

I think the moon was large, and running low, for my shadow which preceded me was frightfully long, while parallel to it, in most forbidding neighborship, lay the dark shadow of a tall Lombardy poplar, as if reflecting some huge monumental shaft. The grave of a sainted mother was near, and a certain sense of her nearness somewhat soothed the fears of that little night waif. I had now got well beyond the saddening shadow of that shaft-like tree, and the exit from the churchyard was but a few steps off, and my courage was beginning to rise, when lo! from out of that dark shaft behind me burst a savage, piercing scream, as it might be of some goblin sentry:

"Who!—who!—who-o-o-oo are you?" How that boy's heart did beat, and how he ran, almost flew, cannot be told. It was still a long way from home, but this was gained at last. He rushed into the house (the folks were up-stairs), and, without reporting to them, he immediately threw himself face downward upon the lounge, and sobbed his fright away, as little people often sensibly do. And now, if better late than never, let it be honestly confessed: that boy for years entertained a very owlish creed, built upon his own experience. He believed in a peculiar graveyard *Strix*. In fine, it may as well come out—he was a spiritualist, in the strictest, spookiest sense.

The owls are intensely carnivorous. The diminutive ones will feed largely upon insects, and some of the large kinds will eat them occasionally. But Nature has made them for prowlers, and as such we find them fond of flesh, fowl, and fish. So immense is their destruction of the smaller rodents, that they are worth millions to the agriculture of our country. They are the feathered Nimrods of the night. Even the American hare, the rabbit wrongly called, falls an easy victim. Some of the owls can fish, too. But whether hunting, fowling, or fishing, they lack the style of doing it which belongs to the falcon tribe; and when out bugging it is but a bungling business

Fig. 2.—American Barn-Owl (*Strix flammea*, Var. *Americana*).

compared with the professional *rôle* of the insectivorous birds. Their angling, too, is simply upon quiet waters. They cannot brave "the mutinous winds 'twixt the green sea and the azured vault." In common with all the *Raptores*, they catch their prey with the talons, not with the beak. In eating birds the owl prefers to tear his prey in piecemeal, but a small rodent is swallowed entire, being usually tossed into the air to adjust its position, so that it may fall head first into the bird's mouth. It disappears in one astonishing gulp. A second gulp is usually needed, as the tail is often after the first left hanging

from one side of the mouth. The indigested mass forms a roundish ball or pellet in the stomach, which the bird vomits up. These pellets or castings indicate what enormous feeders the owls are. One which I took out of the stomach of a little screech-owl was as big as a walnut, and made up of hair and bones, and had in it the skulls of six mice!

While adopting Dr. Coues's specific nomenclature, let us follow John Cassin's distribution of these birds. To aid both memory and judgment, the following scheme is offered:

FAMILY.

Strigidæ.—The Owls.

SUB-FAMILIES.

1. *Striginæ*.—The Typical Owls.
2. *Buboninæ*.—The Horned-Owls.
3. *Syninæ*.—The Gray Owls.
4. *Athenineæ*.—The Bird-Owls.
5. *Nycteininæ*.—The Day-Owls.

1. Among the *Striginæ* we find no large owls, but here are found the typical birds of the family. Here is seen in its highest perfection of form that owlish peculiarity of the face known as the facial disk; that circle of bristle-like, radiating feathers, which helps the big round eyes to their cattish stare. The eyes, however, of the birds in this group, are not so large as are found in some species in the other groups; but the bills of the *Striginæ* are somewhat longer. Here we find the white or barn owl of the authors, which is in fact the world's traditional owl. Its portrait is given in Fig. 1, which is *Strix flammea* (Linn.), the barn-owl of Europe. This and the American barn-owl were long regarded as the same species; but Coues considers it a geographical variety, and, restoring Audubon's name, makes a sub-species of it, thus: *S. flammea*, var. *Americana* (Fig. 2). South of a certain latitude the bird is abundant on both sides of our continent, chiefly near the sea. It is sometimes found in New York and New Jersey, where it breeds in trees with the barest apology for a nest, as the eggs are laid upon the *débris* or cast-up pellets of the bird, which crumble and make a softish but filthy mess. Dr. Newberry states that he saw this bird occupying holes in the perpendicular cliffs on the shores of San Pablo Bay. Wood says the European barn-owl lives in trees and crevices of old buildings, laying its white, rough-surfaced eggs upon a soft layer of its own castings. So intensely pungent is the odor of the nest that it is with difficulty the hand can be washed free of it after meddling with the eggs. The young are described as curious little puffs of white down. The European species is often found feeding a brood of young, while it is hatching another set of eggs. The bird is often tamed, and sometimes

makes a really intelligent pet. The American species is not common in the Middle States. We saw one this spring, a gay, attractive bird, in an hotel at Tom's River, New Jersey. It fairly glowed in a warm, bright tawny hue. In reply to an inquiry, we promptly pronounced it a young barn-owl; but its owner was piqued at the idea that anybody should have seen its like before.

2. The sub-family *Buboninæ*, the eared or horned owls, are so called because of a pair of feathery, ear-like tufts, which are so set upon the head as to have earned for these birds the general name, cat-owls. Their facial disk is not quite perfect. The most famed bird of this group is the great horned-owl (*Bubo Virginianus*, Bonap.) (*see* Fig. 3). This bird has usually a white collar round the neck. It is truly

FIG. 3.—GREAT HORNED-OWL (*Bubo Virginianus*).

a magnificent bird, of indomitable spirit and large size, being about two feet in length. It does not migrate, and is found pretty much all over North America. It breeds in winter and early spring, nesting in hollow trees and crevices of rocks, and is said to build also on some large branch, or in the crotch of a tree. Dr. Coues gives an interesting account of two unfledged ones, which he captured in Dakota, in the month of June. They were his pets for the whole summer, and traveled with him several hundred miles. For a while they had two different notes, the one of hunger or loneliness, a querulous, explosive syllable, and the other a harsh cry of anger, or remonstrance, when rudely handled. They did not begin to hoot until they were about four months old, and then only while at liberty during the night; for, says he, they became so thoroughly tame that, as their wings grew, enabling them to take short flights, I used to release them in the evening from the tether by which they were confined. They enjoyed the liberty, and eventually would stay away all night,

doubtless foraging for themselves for their natural prey, and returning to their shelter behind my tent in the morning.

The adult great horned-owl has considerable vocal ability. At one time it will startle the hearer with a barking like that of a dog; at another time it will utter sounds much like half-suppressed screams, as if of one who is getting throttled; then it will break out into a loud, wild, demoniacal yell of "Waugh O! waugh O!" startling the woods, and almost terrifying every living thing.

I was myself greatly interested in a pair of these young owls, taken from the nest early in March. Big, fluffy things they were, covered with thick, yellow down; and such eaters, nay, gormandizers is the word! It really seemed as if nothing came amiss to their appetites. The offal of chickens—heads, entrails, gizzards—all went down in quick order. One thing surprised me. As we could not at all times obtain animal food for them, my daughter thought of an experiment. She made balls, as large as hickory-nuts, of moistened meal, the outside being flavored with raw eggs. These they took down quite greedily, and, when very hungry, took the meal-balls without the flavoring. It was necessary to feed them with one's fingers. It was amusing to hear them snap their bills when annoyed or made afraid. The report thus made was pretty loud. They grew finely; but soon got killed, when off on a stray.

The little horned-owl is shown by Fig. 4. It is the *Scops asio*

Fig. 4.—The American Screech-Owl (*Scops asio*).

(Bonap.), and is variously known as the American screech-owl, the red owl, and the mottled owl. It is but ten inches long, though that is even two inches longer than its European relative. It ranges through all the Atlantic States, even up to Greenland. Nor is it driven away by the clearing off of the woods; and now more than ever it seeks to be a winter denizen of the city parks, attracted, doubtless, by the abundance of English sparrows, which afford it food. This little

screech-owl, with its staring eyes and pert, ear-like tufts, has a decidedly cattish look. In truth, it wears a grave, grimalkin cast of countenance, which, in a bird, is quite uncanny and unnatural. A mounted specimen in my parlor was an object of dread to a little girl visiting us from the city. It availed nothing to tell the child that little Motley would not hurt her, while the unbird-like little thing would stare at her so.

To the naturalist *Scops asio* has been a provoking elf. It is to be hoped that the sage-looking little fellow did not scoff behind his gravity at these learned men, or count any of them asinine whom he so misled by his eccentric freakiness in dress. Coming before a man of science at one time wearing a suit of sober frieze, again appearing in mottled gray, and anon clad gayly in tawny red, how ludicrously easy and inviting was the trick of specie-making! Well, that controversy is over now, and to write the strife down as history would be enough to make Motley bristle to his toes.

The American long-eared owl (*Otus Wilsonianus*, Less.) (Fig. 5),

Fig. 5.—American Long-eared Owl (*Otus Wilsonianus*).

is a fine bird, some fifteen inches long, and is strictly nocturnal. It often breeds in deserted nests of other large birds; but is not overscrupulous, as it will sometimes drive away the rightful occupant of a nest, and take possession. The facial disk is perfect. Its home is temperate America, up to Hudson's Bay. "Its cry is plaintive, consisting of two or three prolonged notes repeated at intervals."

3. The *Syrninæ*, or gray owls. In this sub-family is found the largest bird of the species known in America; also the smallest specimen east of the Mississippi. Their tails are large and round. Even for owls, they have large heads, but smallish eyes, and no ear-tufts, or these almost unnoticeable. One of these is represented by Fig. 6, the barred owl (*Syrnium nebulosum*, Boie). The average size is twenty

inches. It is common South. A quaint and lively bird, its actions look like antics, for it is an oddity, even among its own folks. His portrait is that of a gay, unsuspecting fellow. He has queer ways, for an owl; he is not sedate enough. In the deep woods, and in broad daylight, when all owldom is abed, he will set up his comical half-laugh, half-cry, "Whah! whah! whah-a-a-aa!" which has in it something of the affectation of an exquisite. He is the dandy-owl—as he has been called the buffoon of the woods.

A much graver person, and the giant of American owls, is the great gray owl (*S. cinerium*, Aud.). His length is thirty inches. The cry is not unlike that of the mottled owl. The bird is common in Canada, and has been shot in New Jersey.

Fig. 6.—The Barred Owl (*Syrnium nebulosum*).

As representing the gray owls well, we must instance the brown or tawny owl, so called in England, although its upper parts are ashen gray (*see* Fig. 7) (*S. aluco*, Linn.). This bird is found in Great Britain, on the Continent, and in Japan. It is only some fifteen inches long, and of retiring habits, as it loves the deep, dark woods, which it will make ring with its dolorous, wolf-like cry of "Hoo! hoo! hoo!" It is an indiscriminate feeder, regaling itself on slugs, insects, small quadrupeds, birds, and fish. And it is quite a clever fisherman in its way, having been known to carry a pound-weight trout to its young. Its mode of angling is to stand stock-still, and patiently, on a protruding stone in a rippling stream, and, when an unsuspicious swimmer comes along, to invest five talons promptly, and take the venture out in fish.

In this group belongs the genus *Nyctale*, which contains the pretty little saw-whet, or Acadian owl (*Nyctale Acadica*, Bonap.). This is the smallest owl in the Eastern and Middle States, being but eight inches long. Its cry is said to resemble the filing or whetting of the teeth

of a saw, so that the traveler hearing it in the woods thinks he hears the man at the saw-mill sharpening the saw. It is also said that its notes resemble those of the little screech-owl of Europe, which would seem to be indicated in the *paronomasia*, or alliteration of the ancient poet:

"Est illis *strigibus* nomen; sed nominis hujus
Causa quod horrenda *stridere* nocte solent."

("The *screakers* they are called; the reason's found—
They make night hideous with their *screaking* sound.")

Nor is it all *screaking* with the saw-whet, for Audubon tells of another note, which is musical, and like the tinkling of a bell. Weight for weight, the robin would probably outdo our little Acadian owl. Nor is it only wee and winsome, it seems to be gentle also. Coues

FIG. 7.—THE TAWNY OWL OF EUROPE (*Syrnium aluco*).

records the interesting fact of one being found occupying peaceably, with a chickaree-squirrel, the same hole in an oak.

Approaching the Western seaboard, we find, under the genus *Glaucidium*, two diminutive owls, the sparrow-pygmy and the rusty pygmy-owl. These birds are not so large as the thrush.

4. The *Athenin*æ, or bird-owls. Here is found that oddly-bird-like owl, standing so un-owlishly high on its naked legs, the burrowing owl (*Athene cunicularia*, Bonap.), or *Speotyto cunicularia*, var. *Hypogæa* of Coues (Fig. 8). Very much nonsense has been written of this bird. It is said to dwell in amity with the rattlesnake and

prairie-dog, which generously shares its hole with bird and snake. The American burrowing owl is essentially a prairie-bird. It occupies, no doubt of choice, the *deserted* burrows of the *Cynomys Ludovicianus* (Baird). But if alarmed, as it would be by the presence of man, it would betake itself to the nearest hole for a refuge. In other lands the burrowing owl has no prairie-dogs to take advantage of, and in these places the owls burrow for themselves. They are diurnal prowlers, feeding chiefly on grasshoppers, crickets, and field-mice, and not improbably an occasional prairie-dog puppy. One species lives entirely

Fig. 8.—The American Burrowing Owl (*Athene cunicularia*).

west of the Mississippi, on both sides of the Rocky Mountains. India has a number of species, which do their own burrow-making, and are an incessantly noisy crew.

We cannot pass by that little marvel, the Liliputian of them all, named Whitney's owl (*Micrathene Whitneyi*, Coues). It was discovered by Dr. Cooper at Fort Mojave in 1860. This owl is an arboreal bird. It is partly diurnal in habit, and feeds on insects. The little thing is hardly as large as the average sparrow.

5. The *Nycteininæ*, or day-owls. This small group has but two genera, with one species in each. But here occurs the very handsomest species of the American owls. Fig. 9 shows that splendid bird known as the snowy owl, the arctic owl (*Nyctea nivea*, Gray). It has been found with a length of twenty-seven inches. Some adults are nearly all white—hence, as a show-bird, it is a favorite. We saw not long since a fine mounted specimen in a New Jersey tavern.

"What a splendid bird!" was our remark to an individual who practised at the bar. "Yes, fine enough when stuffed. But, you see, we had to do it, he got so nasty." We observed that the plumage did not indicate it. The man replied, quickly: "Oh, there was no rummage in him. We kept him tethered. All the rats and mice we ketched was given him—and the way he'd chuck 'em in wasn't slow! But, as I said, he got so nasty." We asked for an explanation. "Well, you see, he got so nasty that, just as lief as not, he'd put his talents right into your hand when you was a-feeding him. You see, the bird got so nasty that he was mean." We replied that it was the first instance of that kind of misdirected "talents" that we had ever heard of, and we agreed with him that it wasn't nice at all. "Nice? Not much!" he rejoined. "As I said, the bird got too nasty, so we killed him, and had him stuffed." He told me the bird was caught in Warren County, and that they used to be plentiful a good many years ago.

FIG. 9.—THE SNOWY OWL (*Nyctea nivea*).

Probably, November, 1876, will go down in ornithological history as the time of the famous southward raid of the snowy owls. Clad as they are to resist the arctic cold, and such excellent hunters—whether by day or by night—it would seem that want of food must have started these birds on their journey. Could the severe arctic winter, so disastrous to Captain Nare's expedition, have made this scarcity? It was during a pleasant autumn that these birds came upon us. There must have been some sixty shot in my own vicinity. A string of thirteen hung by a store in New York; there were many in the markets. One taxidermist in this city, it is said, had sixty left with him to be stuffed. Another in Philadelphia had about as many. As early as September flocks of ten to fifteen were seen in different places in Massachusetts. A number were shot in the city of Boston,

and others were seen perched on the churches and house-tops. For several days they were common in the city and vicinity of Portland, Maine, where not less than one hundred and fifty were shot. A worthy farmer near my home was taking his family to church. A snowy owl sat on a fence by the road, caring nothing for the passing wagon. The good man fretted, "If it wasn't Sunday, I'd bag that chap!" Probably the fellow in Washington Territory was less conscientious, for he filled two barrels with these noble birds! Almost everywhere the village taxidermists in the Eastern and Middle States had a harvest of employment. Says Ruthven Deane: "Many of the specimens were in exceedingly poor condition. Of some two hundred examined by me, nearly all were in very dark plumage, and none wore that almost spotless dress which we occasionally see."

One of these was brought by a pupil to my lecture-room in November. It was a fine fellow, but was badly hurt by the shot. It was given in charge of a young friend, who, as bird-artist, knew the worth of his prize. He kept it in his room, which served for studio and sleep. The bird had the freedom of the room, and became quite gentle, permitting itself to be fondled. One night it persisted in getting on its master's bed. This the jealousy of the hunting-dog could not stand, and every time the bird flew on the bed the dog jumped on and fought it off. At last the young man told the dog to keep quiet, when the bird came again, and, squatting by the side of its owner, kept still for the whole night. It was a great feeder. A weasel which the youth had meant to mount was stolen and devoured by the bird. Muskrats, rabbits, and birds, all went the same way; and to see him dine was a droll sight. He would open wide his great brassy optics, then insert his beak into his prey, then, shutting his eyes excruciatingly tight, would lift his head high, and gulp down whatever he had detached—all of which would be executed in the most grotesque batrachian style: for, who ever saw a frog swallow an insect but that he went it blind? Occasionally it was let out upon the snow. This was indeed a luxury, it was so like home; and the bird would swallow the snow in mouthfuls. A fine owl is this arctic bird! It will smite ducks and grouse on the wing, like a falcon; will swoop upon a hare on the ground, and dart at a fish in the shallows; and it does most of its hunting by day.

In this group occurs also that truly fine bird, the Canada or hawk owl, which is some sixteen inches long. It is often called, from its diurnal habit, the day-owl; for, though an owl, no owler is he. His work is done up clean by daylight, and it is extremely rare to hear of his being abroad at night. Looking now at Fig. 10, the Canada owl (*Surnia ulula*, Bonap.), how easily, upon a casual glance, might one mistake it for a hawk! Like some of the falcons, it will watch from the top of a tree, and will swoop thence upon its prey. It is also arboreal in its nesting, and, with its mate, is splendidly coura-

geous when the safety of person, or home, or young, is in danger. There is not much of the owlish face in our *Surnia*. The facial disk, so prominent an owlish trait, is by no means marked. Still, for all his looks and ways, this same *Surnia* is a true owl. To an unusual degree for his family, he is trim, compact, and graceful. Its favorite home is

FIG. 10.—THE HAWK-OWL (*Surnia ulula*).

in the arctic regions, where "it feeds chiefly on the field-mice (*Arvicolæ*) which swarm in the sphagnous vegetation of those boreal lands; also upon small birds, grasshoppers, and other insects." In severe winters it comes southward, even to the Middle States.

The old philosophers said Nature abhorred a vacuum. Does it not appear from our owlish *résumé* that Nature has an aversion to the abrupt and disconnected? Is it not noticeable that, however natural any two great related groups of animal forms may be, they are not separated by sharp and wholly distinctive lines? There is a shading at the edges into each other. In Biblical speech, the progress of the Divine scheme is literally "little by little," and the lower group gives of the higher one, as Bishop Horseley in a different connection has said, "elegant adumbrations of sacred truth." Only when the extremes of the groups are set in contrast will the family differences best appear. Let one but look a barn-owl and a bald-eagle full in the face of each, and how clear their differentiation! But these are the typical representatives here brought face to face. Suppose we look a moment at Fig. 11, of the marsh-hawk, or harrier (*Circus cyaneus*, Linn.), and then recur to Fig. 10, of the day-owl, or *Surnia*. Now the differentiation almost fades away. How very like they are! But *Surnia* belongs to a more lowly tribe than does *Circus*. The marsh-hawk is an unmistakable falcon, and the other is assuredly an owl. But as respects this harrier, however clear as a whole the title to his

rank may be, there is a strange mix-up in the chirography of the instrument. As to wings and tail and beak and talons, he bears the insignia of a grand connection. It needs an expert to read the document, which, if it shows relation to a noble stock, shows also that Sir Harrier has very ignoble ways. His very mode of hunting is a disgrace to the name of falcon. He will course low in air like a base-born buzzard, and will dog about a small area like a hound after a rabbit, backward and forward, round and round, crossing and recrossing his course, literally scouring a patch of shrub or bush, or perhaps tall reeds or dank meadow, and harrowing the poor occupant so vulture-like, and so utterly unlike the decisiveness of action and brilliancy of dash of the genuine falcon that, with the whir of a rifle-shot, swoops from its observatory in the sky. Not one of these royal points can the marsh-hawk claim. He harries or worries his victim, and so comes honestly by his unenviable name. Although, as a high authority declares, "he is no weakling nor coward," yet he is for his belongings a mean, bullying fellow. Let us watch him from this tree.

Fig. 11.—Marsh-Hawk, or Harrier (*Circus cyaneus*).

He is harrowing a meadow-hen with her young. He has been at this worriment full fifteen minutes. Now he makes a pounce for one of the little ones. But the mother-bird proves herself a heroine on the spur, and puts him to a mean retreat. And then what hawk but he, sloven that he is, would nest upon the ground so vulture-like? There is also a tendency to fluffiness in his plumage, and a cattish noiselessness in his movements, and his queer phiz has a little of the owlish cast. Well, there is no use in denying it, it is true of him, and all these harriers, as Dr. Coues observes, "They look like owls, behave like buzzards, and nest like vultures." Hence, "the marsh-hawk combines, in a notable degree, the characters of several raptorial types, being, in particular, a link between hawks and owls."

But we have not touched bottom; and maybe these are some of His ways which are past finding out. So, having reached the deep waters, we will take that preacher's exordium to his knotty text, and make it the peroration of our discourse: "Brethren, there is mighty deep Scripture here!"

INITIATORY FORCES.

By GEORGE ILES.

LAST September, when the operations for the removal of the obstructions at Hell-Gate, in the harbor of New York, had culminated in the completion of the great labyrinth of tunnels, and the storing therein of a larger quantity of explosives than had ever been used at once before, General Newton, the chief-engineer, at the appointed moment told his little child to gently push a telegraph-key. She did so; her tiny impulse closed the circuit in many hundred galvanic cells; and these, by inflaming the metallic wires in contact with the explosives, freed in an instant the tremendous power which had been slumbering under the peaceful waters.

Perhaps in the whole realm of human achievement no more striking example of an initiatory force has ever been given than this. And if it had not had an appearance of trifling, it would doubtless have been quite possible for matters to have been so arranged that a fly imprisoned in an inverted wineglass could by the vibration of its little wings have brought two delicate electric conductors into contact—say two moistened silken filaments—and have thus pulled the trigger which, in the course of its effects, would have made Hell-Gate navigable.

In Nature and art we find abundant examples of the same kind: gigantic forces, perfectly quiescent and even useless, until some slight additional force of the proper kind or intensity precipitates the most violent changes. And this necessity for an outside initiatory force is generally found with great power to maintain action once begun. Carbon, and fuels of all kinds, are instances in point. As a rule, they are but little altered by contact with the atmosphere, even for years; but a match has only to be applied to a few shavings, and a mine of coal may be set on fire so thoroughly that it continues burning for half a century. A prairie or forest may be dried up by drought until leaves and twigs are brittle and dead, but all is calm until a chance spark from a locomotive or a tobacco-pipe starts a fire that may devastate square leagues of territory in its course.

In all cases of unstable equilibrium—and such abound in Nature—a very small impetus may produce great consequences; and this not only in amount but direction. With an avalanche perched on a moun-

tain-peak, it has often been a very slight force that has determined the path it has taken, and which of two villages miles apart was to be demolished by it. The fire-alarm system in our cities uses electricity as an initiatory motion: the hammers of the tower-bells are worked by the descent of heavy weights—wound up by manual power from time to time—and the store of energy contained in the elevated masses is instantly made available by an electric current from the central office simply freeing a detent and allowing the weight to fall. Many other recent inventions for working railway-signals, looms, etc., embody this principle. The magneto-electric machines, which are extensively employed in lighthouses and electro-plating factories, yield electricity from the mechanical motion of a steam-engine. A small permanent steel magnet is indispensable in the apparatus; it induces magnetism in soft-iron cores, and these again in others in an increasing series. The power may be gigantic, and the magnet, were it not inconvenient, might be as small as a cambric needle: yet without it neither electricity nor light can be had. A similar illustration occurs in the development of a current in a common galvanic battery: the two pieces of different metals used, as zinc and copper, when quite dry before being placed in the bath, if simply brought into contact for a moment show opposite electric polarities which, if given a mechanical expression, would be a very small amount indeed. This minute force, only to be detected by the most delicate means, is the necessary opening of the flood-gate of energy in a working battery. And when light is desired from a group of powerful cells, it is first requisite to use a small effort in bringing the poles together, and then separating them at a short distance apart. The brilliant arc of light, once across the chasm, can continue to span it; but its force, although so great, is unequal to leaping over it without help. These examples show the importance of knowing the fit initiatory forces in processes whereby one form of energy is sought to be converted into another. It is probably for lack of such knowledge that at present we waste so lamentable a quantity of heat, our commonest force, in changing it into the more desirable form of electricity, light, and mechanical motion. In exceptionally favorable circumstances, steam-engines of the best kind give but a fourth in work of the theoretical value of the heat applied, and in obtaining an electric current from an engine further loss occurs; while the production in a thermo-battery of a current from heat directly has never yet yielded as much as one-hundredth of the force employed.

A slight and well-aimed effort may not only free an immense magazine of energy, but also give it a particular direction and pilot it into one or another of two entirely new seas. Hydrogen and oxygen gases in separate receivers might remain tranquil and unchanged for ages, and it depends upon the choice of the experimenter, when he wishes to render their energy available, whether their intense chemical force

shall take the form of heat or give forth an electric current. In the former case he shall connect the receivers together by suitable tubes, apply a spark, and obtain a flame hot enough to fuse and vaporize iron or platinum. In the other case he can use Grove's gas-battery, and permit the elements to unite into water, producing an intense electric current capable of working scores of miles of telegraph. The realm of light yields us examples analogous to those given in the domains of heat and electricity. In photography it has been discovered that blue rays may begin an impression which red or yellow ones can finish, and finish only. The power of continuance is different from the power of initiation, and depends upon it for its opportunity of usefulness.

The instability of equilibrium among forces brings in an element of uncertainty, or rather incalculability, which renders prediction extremely difficult in many fields of scientific investigation. Prof. Balfour Stewart, in a most instructive essay on "Solar Physics," gives us some illustrations of this. He supposes a stratum of air in the earth's atmosphere to be very nearly saturated with aqueous vapor; that is to say, just a little above the dew-point; while at the same time it is losing heat with extreme slowness, so that if left to itself it would be a long time before moisture were deposited. Now, such a stratum is in an extremely delicate state of molecular equilibrium, and the dropping into it of a small crystal of snow would at once cause a remarkable change of state. For what would happen? The snow would cool the air around it, and thus moisture would be deposited in the form of fine mist or dew. Now, this deposited mist or dew, being a liquid, and as such much more radiant than vapor, would send its heat into empty space much more rapidly than the saturated air; and therefore it would become colder than the air around it. Thus, more air would be cooled, and more mist or dew deposited; and so on until a complete change of condition should be brought about, resulting perhaps in a shower of rain. Now, in this imaginary case, the tiniest possible flake of snow has pulled the trigger, as it were, and made the gun go off—has changed completely the whole arrangement that might have gone on for some time longer as it was, had it not been for the advent of the snow-flake. Prof. Stewart thus points out that the presence of a condensable liquid in our atmosphere adds an element of violence, and also of abruptness, amounting to incalculability, to the motions which take place. Hence meteorology must long, if not ever, remain an incomplete science, since in its problems so many variable and unstable factors occur. In the course of the same essay Prof. Stewart tells us how parallelism has been observed between three very interesting classes of phenomena, namely, the periods of maximum sun-spots, of brilliant auroral displays, and of great disturbances in the earth's magnetism. Extended observatory records show that all three coincide in their fluctuations; hence endeavors have been made to

trace them to a common source. Observations at Kew for a series of years have detected that the proximity of Mercury and Venus to the sun seems to control the size and direction of the solar spots; and therefore it appears that these planets mediately through the sun cause our auroras and magnetic storms. There is also reason to believe that the production of sun-spots diminishes by absorption the actinic rays, while the thermal ones are not noticeably affected; for to the actinic rays the chemical or ripening effect is due. Years of minimum sun-spots have been found to coincide very nearly with the good wine-years in Germany. At first sight we are startled by the supposition that a planet like Venus, which comes nearer to the earth than it ever does to the sun, should in any way be accountable for such enormous manifestations of energy as those which occur over the sun's surface. But the wonder will disappear if we bear in mind that there may be two kinds of causes or antecedents. Thus, we say that the blacksmith is the cause of the blow which his hammer strikes the anvil, and here the strength of the blow depends upon the strength of the smith. But we may likewise say that the man who pulls the trigger of a gun or cannon is the cause of the motion of the ball, and here there is no relation between the strength of the effect and that of its cause. Now, in whatever mysterious way Venus and Mercury affect the sun, we may be sure it is not after the fashion of the blacksmith: they do not deal him a violent blow producing all this enormous effect, but they rather pull the trigger, and immediately a very great change takes place. And, in passing, we are here taught how involved the relations of the parts of the universe may be. Two planets whose direct influence on the earth by their gravitation and light is quite inconsiderable, yet, by their indirect effects through their action on the sun, produce very marked and varied results on the surface of our globe. Many laboratory experiments, on a small scale, illustrate the potency of initiatory forces. A pail of water, maintained in great stillness, may be gradually chilled several degrees below the common freezing-point, when the formation of a cake of ice instantly follows from a slight shake. A clean glass vessel may be filled with water and slowly brought to a temperature in excess of the ordinary boiling-point, and a feeble shock is all that is needed for the prompt liberation of a large volume of steam. Crystallization offers similar results. A supersaturated solution of a salt may long remain in the liquid state until a crystalline fragment thrown in instantly serves as a nucleus for extensive solidification. When such a solution contains two salts, which begin to crystallize about the same temperature, when a solid fragment of each kind is thrown into the liquid, it picks out its kindred without the slightest error, and grows thereby. A new surgical method for covering a wound with skin employs as centres of growth tiny morsels of skin supplied from elsewhere. These gather together elements akin to themselves, and soon

repair the injury, otherwise very slow at healing. In some similar way it must be that a small seed of a plant selects just such ingredients from the soil as shall make it thrive and increase. On these organic powers of initiation and selection, Lucretius ponders in his great poem, and wonders how it is that different animals—the pig, dog, and fowl—eat the same food and yet make of it such diverse substance. On a seed's peculiar nature it may follow whether a field shall give its substance to maples or cabbages. Just so a volcanic island's population depends, to a large extent, on the first comers—on what human tribe first lands there, what seeds and insects are first wafted upon it, and what birds first alight on its shores. Once in possession, the process of multiplication soon renders occupancy by stray creatures of superior kinds impossible; and so we have incidentally a case where the best may not be the conquerors and survivors. Mere precedence in time is often of much account. No man shall ever have as many children as Adam. The first poets exhausted the most striking and beautiful similes in Nature, such as now may independently but uselessly occur to every cultured imagination. The limits of choice in the subjects for invention, authorship, and art, are constantly narrowed by the occupation of territory by those who have gone before. Of course, infinite additions to knowledge and achievement are possible, but many efforts suggested by the wants of the time, though quite original, are fruitless simply because they do not happen to be first.

With respect to the great effectiveness of force, when used largely or totally in initiation, Prof. Stewart thinks that intelligence depends on conditions in the organism of unstable equilibrium, and he draws a parallel between the great powers of a human mind and the marked decomposibility of its brain-substance. The particular supremacy of man in Nature is thus traced to a principle which highly characterizes his own frame, and of which he avails himself in his mastery of external Nature—delicacy of poise in construction rendering large powers obedient to slight ones.

Our subject further suggests the importance of leadership among mankind. Heroes have been so unduly praised that a reaction has set in with many thinkers, who would detract from their real value. Popular discontent, or a wide-spread spirit of enterprise, often lingers in useless agitation for want of some man a little bolder than the rest, who shall make the first onslaught on tyranny, or captain the first ship that shall set its prow toward the shores of a new world. To be sure, a hero is no more than a representative of the strong feelings of his land and time; yet, without his faith and enthusiasm, perhaps but little more than that of many of his neighbors, their desires and hopes might never have fulfillment.

Finally, our theme shows us the immense difficulties in the way of reducing some inquiries of deep interest to exact treatment. If the

problems of meteorology are of baffling intricacy, how much more so are those of history, with their elements of ignorance, of passion, and caprice—all controlling forces vastly greater than themselves! We have recently seen a few votes among hundreds decide the administration of the republic for years; and, within a decade, have beheld a single general's timidity or treachery betray a noble army into the enemy's hands, involving wide-spread ruin and deep national disgrace. And how often are our own individual lives utterly changed in purpose by a mere word, a smile, or a tear!

MESMERISM, ODYLISM, TABLE-TURNING, AND SPIRITUALISM.

By WILLIAM B. CARPENTER, C. B., M. D., LL. D., F. R. S.

II.

IT was asserted, about thirty years ago, by Baron von Reichenbach, whose researches on the chemistry of the hydrocarbons constitute the foundation of our present knowledge of paraffin and its allied products of the distillation of coal, that he had found certain "sensitive" subjects so peculiarly affected by the neighborhood of magnets or crystals as to justify the assumption of a special polar force, which he termed *Odyle*, allied to, but not identical with, magnetism; present in all material substances, though generally in a less degree than in magnets and crystals; but called into energetic activity by any kind of physical or chemical change, and therefore especially abundant in the human body. Of the existence of this odylic force, which he identified with the "animal magnetism" of Mesmer, he found what he maintained to be adequate evidence in the peculiar sensations and attractions experienced by his "sensitives" when in the neighborhood either of magnets or crystals, or of human beings specially charged with it. After a magnet had been repeatedly drawn along the arm of one of these subjects, she would feel a pricking, streaming, or shooting sensation; she would smell odors proceeding from it; or she would see a small volcano of flame issuing from its poles when gazing at them, even in broad daylight. As in the magnetic sleep light is often seen by the somnambule to issue from the operator's fingers, so the odylic light was discerned in the dark by Von Reichenbach's "sensitives," issuing not only from the hands, but from the head, eyes, and mouth, of powerful generators of this force. One individual in particular was so peculiarly sensitive, that she saw (in the dark) sparks and flames issuing from ordinary nails and hooks in a wall. It was further affirmed that certain of

these "sensitives" found their hands so powerfully attracted by magnets or crystals as to be irresistibly drawn toward them; and thus that if the attracting object were forcibly drawn away, not only the hand, but the whole body of the "sensitive" was dragged after it. Another set of facts was adduced to prove the special relation of odyle to terrestrial magnetism—namely, that many "sensitives" cannot sleep in beds which lie across the magnetic meridian; a position at right angles to it being to some quite intolerable.

Von Reichenbach's doctrine came before the British public under the authority of the late Dr. Gregory, the Professor of Chemistry in the University of Edinburgh; who went so far as to affirm that, "by a laborious and beautiful investigation, Reichenbach had demonstrated the existence of a force, influence, or imponderable fluid—whatever name be given to it—which is distinct from all the known forces, influences, or imponderable fluids, such as heat, light, electricity, magnetism, and from the attractions, such as gravitation, or chemical attraction." It at once became apparent, however, to experienced physicians conversant with the proteiform manifestations of that excitable, nervous temperament, of which I have already had to speak, that all these sensations were of the kind which the physiologist terms "subjective;" the state of the sensorium on which they immediately depend being the resultant, not of physical impressions made by external agencies upon the organs of sense, but of cerebral changes connected with the ideas with which the minds of the "sensitives" had come to be "possessed." The very fact that no manifestation of the supposed force could be obtained except through a conscious human organism should have been quite sufficient to suggest to any philosophic investigator that he had to do not with a new physical force, but with a peculiar phase of physical action, by no means unfamiliar to those who had previously studied the influence of the mind upon the body. And the fact which Von Reichenbach himself was honest enough to admit—that when a magnet was poised in a delicate balance, and the hand of a "sensitive" was placed above or beneath it, the magnet was never drawn toward the hand—ought to have convinced him that the force which attracted the "sensitive's" hand to the magnet has nothing in common with physical attractions, whose action is invariably *reciprocal;* but that it was the product of her own conviction that she *must* thus approximate it. So "possessed" was he, however, by his pseudo-scientific conception, that the true significance of this fact entirely escaped him; and although he considered that he had taken adequate precautions to exclude the conveyance of any suggestion of which his "sensitives" should be conscious, he never tried the one test which would have been the *experimentum crucis* in regard to all the supposed influences of magnets—that of using *electro-magnets*, which could be "made" and "unmade" by completing or breaking the electric circuit, with-

out any indication being given to the "sensitive" of this change of its conditions. And the same remark applies to the more recent statement of Lord Lindsay, as to Mr. Home's recognition of the position of a permanent magnet in a totally-darkened room; the value of this solitary fact, for which there are plenty of ways of accounting, never having been tested by the use of an electro-magnet, whose active or passive condition should be entirely unknown, not only to Mr. Home but to every person present.

That "sensitives" like Von Reichenbach's, in so far as they are not intentional deceivers (which many hysterical subjects are constitutionally prone to be), can feel, see, or smell, anything that they were led to believe that they *would* feel, see, or smell, was soon proved by the experimental inquiries of Mr. Braid, many of which I myself witnessed. He found that not only in hysterical girls, but in many men and women "of a highly-concentrative and imaginative turn of mind," though otherwise in ordinary health, it was sufficient to fix the attention on any particular form of *expectancy*—such as pricking, streaming, heat, cold, or other feelings, in any part of the body over which a magnet was being drawn; luminous emanations from the poles of a magnet in the dark, in some cases even in full daylight; or the attraction of a magnet or crystal held within reach of the hand—for that expectancy to be fully realized. And, conversely, the same sensations were equally produced when the subjects of them were led to *believe* that the same agency was being employed, although nothing whatever was really done; the same flames being seen when the magnet was concealed by shutting it in a box, or even when it was carried out of the room, without the knowledge of the subject; and the attraction of the magnet for the hand being entirely governed by the idea previously suggested, positive or negative results being thus obtained with either pole, as Mr. Braid might direct. "I know," he says of one of his subjects, "that this lady was incapable of trying to deceive myself or others present; but she was self-deceived and spell-bound by the predominance of a preconceived idea, and was not less surprised at the varying powers of the instrument than were others who witnessed the results."[1]

One of Mr. Braid's best "subjects" was a gentleman residing in Manchester, well known for his high intellectual culture, great general ability, and strict probity. He had such a remarkable power of voluntary abstraction as to be able at any time to induce in himself a state akin to profound reverie (corresponding to what has been since most inappropriately called the "biological"), in which he became so completely "possessed" by any idea strongly enforced upon him, that his whole state of feeling and action was dominated by it. Thus it was sufficient for him to place his hand upon the table and fix his attention upon it for half a minute, to be entirely unable to withdraw

[1] "The Power of the Mind over the Body," 1846, p. 20.

it, if assured in a determined tone that he *could not* do so. When his gaze had been steadily directed for a short time to the poles of a magnet, he could be brought to see flames issuing from them of any form or color that Mr. Braid chose to name. And when desired to place his hand upon one of the poles, and to fix his attention for a brief period upon it, the peremptory assurance that he *could not* detach it was sufficient to hold it there with such tenacity that I saw Mr. Braid drag him round the room in a way that reminded me of George Cruikshank's amusing illustration of the German fairy-story of "The Golden Goose." The attraction was dissolved by Mr. Braid's loud, cheery "All right, man," which brought the subject back to his normal condition, as suddenly as the attraction of a powerful electro-magnet for a heavy mass of iron ceases when the circuit is broken.

Similar experiments to these (which I first witnessed about thirty years ago) have been since repeated over and over again upon great numbers of persons, in whom a corresponding state can be induced by prolonged fixation of the vision on a small object held in the hand. It was in the year 1850 that a new manifestation of the supposed "occult" power first attracted public attention, through the exhibition of it by a couple of itinerant Americans, who styled themselves "professors," of a new art which they termed *Electro-Biology;* asserting that by an influence of which the secret was only known to themselves, but which was partly derived from a little disk of zinc or copper held in the hand of the "subject" and steadily gazed on by him, they could subjugate the most determined will, paralyze the strongest muscles, pervert the evidence of the senses, destroy the memory of even the most familiar things or of the most recent occurrences, induce obedience to any command, or make the individual believe himself transformed into any one else; all this, and much more, being done while he was still wide awake. They soon attracted large assemblages to witness their performances, and seldom failed to elicit some of the most remarkable phenomena from entire strangers to them, whose honesty could not be reasonably called in question. In place of a few peculiarly susceptible "subjects" not always to be met with, and open to suspicion on various grounds, those who took up this practice found in almost every circle some individuals in whom the "biological" state could be self-induced by the steady direction of their eyes to one point, at the ordinary reading-distance, for a period usually varying from about five to twenty minutes; a much shorter time generally sufficing in cases in which the practice had been frequently repeated. In this condition, the whole course of thought is directed by external suggestions, the subject's own control over it being altogether suspended. Yet he differs from the somnambulist, in being *awake;* that is, he has generally the use of all his senses, and usually, though not always, preserves a distinct recollection of all that has taken place. There is, in fact, a gradational

transition from the "biological" to the "mesmeric" state; just as there is a passage from the state of profound reverie or "day-dreaming" to that of ordinary sleep. All its strange phenomena are referable to one simple principle—the possession of the mind by a *dominant idea*, from which, however absurd it may be, the subject cannot free himself by bringing it to the test of actual experience, because the suspension of his self-directing power prevents him from correcting his ideational state by comparing it with external realities; this suspension being often as complete as it is in dreaming, so that, though the senses are awake, they cannot be turned to account. But it may exist in regard to one sense only, the impressions made on others being truly represented to the mind. Thus I have seen instances in which a "biologized" subject could be made to believe himself to be *tasting* anything which the operator might assure him that he *would* taste—such as milk, coffee, wine, or porter—when drinking a glass of pure water, though he was instantly disabused by *looking* at the liquid; while another would *see* milk or coffee, wine or porter, as he was directed, but would instantly set himself right when he *tasted* the liquid. Nothing can be more amusing than to experiment upon a subject who has no misgivings of this kind, but whose perceptions are altogether under the direction of the ideas impressed upon him. He may be made to exhibit all the manifestations of delight which would be called forth by the viands or liquors of which he may be most fond, and these may be turned in a moment into expressions of the strongest disgust, by simply giving the word which shall (ideally) change it into something he detests. Or if, when he believes himself to be drinking a cup of tea or coffee, he be made to believe that it is very hot, nothing will induce him to take more than a sip at a time; yet a moment afterward he will be ready to swallow the whole in gulps, if assured that the liquid is quite cool. Tell him, again, that his seat is growing hot under him, and that he will not be able to remain long upon it, and he will fidget uneasily for some time, and at last start up with all the indications of having found the heat no longer bearable. While he is firmly grasping a stick in his hand, let him be assured that it will burn him if he continue to hold it, or that it is becoming so heavy that he can no longer sustain it, and he will presently drop it with gestures conformable in each case to the idea.

It may, of course, be said that what I have presented to you as real phenomena are only simulated; and as there would be nothing difficult in such simulation, the supposition is of course admissible. But they are so perfectly conformable to the known principles of Mental action, that there is no justification for the suspicion of deceit, when they are presented by persons in whose good faith we have reasonable grounds of confidence. For every one must be conscious of occasional mistakes as to what he supposes himself to have seen or

heard, which he can trace to a previous expectancy. Of this I can give you a very striking illustration in a case narrated by Dr. Tuke. A lady, whose mind had been a good deal occupied on the subject of drinking-fountains, was walking from Penrhyn to Falmouth, and thought she saw in the road a newly-erected fountain, with the inscription, "If any man thirst, let him come hither and drink." Some time afterward, on mentioning the fact with pleasure to the daughters of a gentleman whom she supposed to have erected it, she was greatly surprised to learn from them that no such drinking-fountain existed; and, on subsequently repairing to the spot, she found nothing but a few stones, which constituted the foundation on which her expectant imagination had built an ideal superstructure.

The same may be said with regard to the control exercised over the muscular movements of the biologized "subject," by the persuasion that he *must* or that he *cannot* perform a particular action. His hands being placed in contact with one another, he is assured that he cannot separate them, and they remain as if firmly glued together, in spite of all his apparent efforts to draw them apart. Or, a hand being held up before him, he is assured that he cannot succeed in striking it; and not only does all his power seem inadequate to the performance of this simple action, but it actually is so as long as he remains convinced of its entire impossibility. So I have seen a strong man chained down to his chair, prevented from stepping over a stick on the floor, or obliged to remain almost doubled upon himself in a stooping position, by the assurance that he *could not* move. On the other hand, an extraordinary power may be called forth in any set of muscles—as in hypnotized subjects—by the assurance that the action to be performed by them may be executed with the greatest facility. This, again, is quite conformable to ordinary experience; the assurance that we *can* perform some feat of strength or dexterity nerving us to the effort; while our power is weaken l by our own doubts of success, still more by the unfavorable impression produced by a confident prediction of failure. It is only needed for the mind to become completely "possessed" by the one or the other conviction for it to produce the bodily results of this kind which I have over and over again witnessed.

Now the phenomena of the "biological" condition seem to me of peculiar significance, in relation to a large class of those which are claimed as manifestations of a supposed "spiritual" agency. When a number of persons of that "concentrative and imaginative turn of mind" which predisposes them to the "biological" condition sit for a couple of hours (especially if in the dark) with the expectation of some extraordinary occurrence—such as the rising and floating in the air, either of the human body, or of chairs or tables, without any physical agency; the crawling of live lobsters over their persons; the contact of the hands, the sound of the voices, or the visible luminous

shapes,[1] of their departed friends—it is perfectly conformable to scientific probability that they should pass more or less completely (like Reichenbach's "sensitives") into a state which is neither waking nor sleeping, but between the two, in which they see, hear, or feel, by touch, anything they have been led to expect will present itself. And the accordance of their testimony, in regard to such occurrences, is only such as is produced by the community of the dominant idea with which they are all "possessed," a community of which history furnishes any amount of strangely-varied examples. And thus it becomes obvious that the testimony of a single cool-headed skeptic, who asserts that nothing extraordinary has really occurred, should be accepted as more trustworthy than that of any number of believers, who have, as it were, created the sensorial result by their anticipation of it.

I have now to show you that the like expectancy can also produce *movements* of various kinds, through the instrumentality of the nervo-muscular apparatus, without the least consciousness on the part of its subject of his being himself the instrument of their performance; a physiological fact which is the key to the whole mystery of table-turning and table-talking. I very well remember the prevalence in my schoolboy days of a belief that, when a ring, a button, or any other small body, suspended by a string over the end of the finger, was brought near the outside or inside of a glass tumbler, it would strike the hour of the day against its surface; and the experiment certainly succeeded in the hands of several of my schoolfellows, who tried it in all good faith, getting up in the middle of the night to test it, in entire ignorance, as they declared, of the real time. But, as was pointed out by M. Chevreul, who investigated this subject in a truly scientific spirit more than forty years ago,[2] it is impossible by any voluntary effort to keep the hand absolutely still for a length of time in the position required; an involuntary tremulousness is always observable in the suspended body, and if the attention be fixed on it with the expectation that its vibrations will take a definite direction, they are very likely to do so. But their persistence in that direction is found to last only so long as they are guided by the sight of the operator, at once and entirely losing their constancy if he closes or turns away his eyes. Thus it became obvious that, in the striking of the hour, the influence which determines the number of strokes is really the knowledge or suspicion present to the *mind* of the operator, which involuntarily and unconsciously directs the action of his muscles; and the same *rationale* was applied by M. Chevreul to other cases in which this *pendule explorateur* (the use of which can be traced

[1] I put aside the question of fraud, to which recourse has doubtless often been had for the production of these phenomena; being satisfied that they are often genuinely "subjective."

[2] *See* his letters to M. Ampère, in the *Revue des Deux Mondes*, May, 1833.

back to a very remote date) has been appealed to for answers to questions of very diverse character.

When, however, "Odyle" came to the front, and the world of curious but unscientific inquirers was again "possessed" by the idea of an unknown and mysterious agency, capable of manifesting itself in an unlimited variety of ways, the *pendule explorateur* was brought into vogue, under the name of *odometer*, by Dr. Herbert Mayo,[1] who investigated its action with a great show of scientific precision; starting, however with the foregone conclusion that its oscillations were directed by the hypothetical "odyle," and altogether ignoring the mental participation of the operator, whom he supposed to be as passive as a thermometer or a balance. By a series of elaborate experiments, he convinced himself that the direction and extent of the oscillations could be altered, either by a change in the nature of the substances placed beneath the "odometer," or by the contact of the hand of a person of the opposite sex, or even of the experimenter's other hand, with that from which it was suspended. And he gradually reduced his result to a series of definite laws, which he regarded as having the same constancy as those of physics or chemistry. Unfortunately, however, other experimenters, who worked out the inquiry with similar perseverance and good faith, arrived at such different results, that it soon came to be obvious that what astronomical observers call the "personal equation" of the individual has a very large share in determining them. A very intelligent medical friend of my own, then residing abroad, wrote me long letters full of the detailed results of his own inquiries, on which he was anxious for my opinion. My reply was simply: "Shut your eyes, or turn them away, and let some one else watch the oscillations under the conditions you have specified, and record their results; you will find, if I do not mistake, that they will then show an entire *want* of the constancy you have hitherto observed." His next letter informed me that such proved to be the case; so that he had come entirely to agree with me as to the dependence of the previous uniformity of his results on his own expectancy.

A curious variation of the "odometer" was introduced by Mr. Rutter, the manager of the gas-works at Brighton, under the name of "magnetometer," which was simply a gallows-shaped frame, mounted on a solid base, having a metallic ball suspended from its free extremity. When the finger was kept for a short time in contact with this frame, the ball began to oscillate, usually in some definite direction, changing that direction with any change of circumstances, after the manner of Dr. Mayo's "odometer." To many persons, as to Mr. Rutter himself, it appeared impossible that these oscillations could have their origin in any movement of the operator; but every one who knows how difficult it is to prevent vibrations in the sup-

[1] "The Truths contained in Popular Superstitions," 1851.

porting framework of a microscope or telescope, and who recognizes that the construction of the "magnetometer" is exactly such as will enable the smallest amount of imparted motion to produce the greatest sensible effect, will be prepared to expect that the oscillations of the suspended ball are as much maintained and guided by the expectancy of the operator as they are when it is hung directly from his own finger. Experiment soon proved this to be the case: for it was found that the constancy of the vibrations entirely depended upon the operator's watching their direction, either by his own eyes or by those of some one else; and, further, that when such a change was made *without his knowledge* in the conditions of the experiment, as *ought*, theoretically, to alter the direction of the oscillations, no such alteration took place.

A very amusing *exposé* of the mystery of the "magnetometer" resulted from its application by Dr. Madden, an homœopathic physician at Brighton, to test the virtues of his "globules," as to which he had, of course, some preformed conclusions of his own. The results of his first experiments entirely corresponded with his ideas of what they ought to be; for when a globule of one medicine was taken into his disengaged hand, the suspended ball oscillated longitudinally; and when this globule was changed for another of opposite virtues, the direction of the oscillations became transverse. Another homœopathic physician, however, was going through a similar course of experiments; and his results, while conformable to his own notions of the virtues of the globules, were by no means accordant with those of Dr. Madden. The latter was thus led to reinvestigate the matter with a precaution he had omitted in the first instance; namely, that the globules should be placed in his hand by another person, without any hint being given him of their nature. From the moment he began to work upon this plan, the whole aspect of the subject was changed; globules that produced longitudinal oscillations at one time gave transverse at another, while globules of the most opposite remedial virtues gave no sign of difference. And thus he was soon led to the conviction, which he avowed with a candor very creditable to him, that the system he had built up had no better foundation than his own anticipation of what the results of each experiment should be; that anticipation expressing itself unconsciously in involuntary and imperceptible movements of his finger, which communicated a rhythmical vibration to the framework when the oscillations of the ball suspended from it were watched.

Thus, by the investigations of scientific experts who were alive to the sources of fallacy which the introduction of the *human* element always brings into play, the hypothesis of odylic force was proved to be completely baseless; the phenomena which were supposed to indicate its existence being traceable to the physiological conditions of the human organisms through whose instrumentality they were mani-

fested. The principle that the state of "expectant attention" is capable of giving rise either to sensations or to involuntary movements, according to the nature of the expectancy, had been previously recognized in physiological science, and was not invented for the occasion; but the phenomena I have been describing to you are among its most "pregnant instances."

The same principle furnishes what I believe to be the true scientific explanation of the supposed mystery of the divining-rod, often used where water is scarce for the discovery of springs, and in mining-districts for the detection of metallic veins. This rod is a forked twig shaped like the letter Y, hazel being usually preferred; and the diviner walks over the ground to be explored, firmly grasping its two prongs with his hands, in such a position that its stem points forward. After a time the end of the stem points downward, often, it is said, with a sort of writhing or struggling motion, especially when the fork is tightly grasped; and sometimes it even turns backward, so as to point toward instead of away from the body of the diviner. Now, there is a very large body of apparently reliable testimony, that when the ground has been opened in situations thus indicated, either water-springs or metallic veins have been found beneath; and it is quite certain that the existence of such a power is a matter of unquestioning faith on the part of large numbers of intelligent persons who have witnessed what they believe to be its genuine manifestations.[1] This subject, however, was carefully inquired into more than forty years ago by MM. Chevreul and Biot; and their experimental conclusions anticipated those to which I was myself led in ignorance of them by physiological reasoning. They found that the forked twig cannot be firmly grasped for a quarter of an hour or more in the regulation position, without the induction of a state of muscular tension, which at last discharges itself in movement; and this acts on the prongs of the fork in such a manner as to cause its stem to point, either upward, downward, or to one side. The occasion of this discharge and the direction of the movement are greatly influenced, like the oscillations of bodies suspended from the finger, by *expectancy* on the part of the operator; so that if he has any suspicion or surmise as to the "whereabouts" of the object of his search, an involuntary and unconscious action of his muscles causes the point of the rod to dip over it.

Again, since not one individual in forty, in the localities in which the virtues of the divining-rod are still held as an article of faith, is found to obtain any results from its use, it becomes obvious that its movements must be due, not to any physical agency directly affecting the rod, but to some influence exerted through its holder. And that this influence is his *expectation* of the result may, I think, be pretty confidently affirmed. For it has been clearly shown, by careful and

[1] I have lately received a pamphlet from an engineer in the United States, giving most circumstantial details of success thus obtained within his own experience.

repeated experiments, that, while the rod dips when the "diviner" knows or believes he is over a water-spring or a metallic vein, the results are uncertain, contradictory, or simply negative, when he is blindfolded, so as not to be aware precisely where he is. The following is a striking case of this kind that has been lately brought to my knowledge:

"A friend of mine," says Dr. Beard,[1] "an aged clergyman, of thorough integrity and fairness, has for many years—the larger part of his natural life, I believe—enjoyed the reputation of being especially skilled in the finding of places to dig wells, by means of a divining-rod of witch-hazel, or the fresh branches of apple or other trees. His fame has spread far, and the accounts that are given by him and of him are, to those who think human testimony is worth anything, overwhelmingly convincing. He consented to allow me to experiment with him. I found that only a few moments were required to prove that his fancied gift was a delusion, and could be explained wholly by unconscious muscular motion, the result of expectancy and coincidence. In his own yard there was known to be a stream of water running through a small pipe a few feet below the surface. Marching over and near this, the rod continually pointed strongly downward, and several times turned clear over. These places I marked, blindfolded him, marched him about until he knew not where he was, and took him over the same ground over and over again; and, although the rod went down a number of times, *it did not once point to or near the places previously indicated.*"

I very well remember having heard, some thirty-five years ago, from Mr. Dilke (the grandfather of the present Sir Charles), of an experiment of this kind which he had himself made upon a young Portuguese, who had come to him with a letter of introduction, describing the bearer of it as possessing a most remarkable power of finding, by means of the divining-rod, metals concealed from view. Mr. Dilke's family being at a summer residence in the country, his plate had all been sent to his chambers in the Adelphi, where he was visited by the Portuguese youth; to whom he said, "Go about the room with your rod, and try if you can find any mass of metal." The youth did so; and his rod dipped over a large standing desk, in which Mr. Dilke's plate had been temporarily lodged. Seeing, however, that there were circumstances which might reasonably suggest this guess, Mr. Dilke asked the youth if he was willing to allow his divining power to be tested under conditions which should exclude all such suggestion; and, having received a ready assent, he took his measures accordingly. Taking his plate-box down to his country residence, he secretly buried it just beneath the soil in a newly-ploughed field; selecting a spot which he could identify by cross-bearings of conspicuous trees, and getting a plough drawn again over its surface, so as to make this correspond precisely with that of the rest of the field. The young diviner was then summoned from Lon-

[1] *Review of Medicine and Pharmacy* (New York), September, 1875.

don, and challenged to find beneath the soil of this field the very same plate which he had previously detected in Mr. Dilke's desk at the Adelphi; but, having nothing watever to guide him even to a guess, he was completely at fault. Mr. Dilke's impression was that he was not an impostor, but a sincere believer in his own power, as the "dowsers" of mining-districts seem unquestionably to be. The test of blindfolding the diviner, and then leading him about in different directions, so as to put him completely at fault in regard to his locality, is one that can be very readily applied, when the diviner is acting in good faith; but, as I shall show you in the next lecture, it requires very special precautions to blindfold a person who is determined to see; and, in some of the cases which seem to have stood this test, it seems not improbable that vision was not altogether precluded.

An additional reason for attributing the action of the divining-rod to the muscular movements called forth by a state of expectancy (perhaps not always consciously entertained) on the part of the performer seems to me to be furnished by the diversity of the powers that have been attributed to it; such as that of identifying murderers and indicating the direction of their flight, discovering the lost boundaries of lands, detecting the birthplace and parentage of foundlings, etc. The older writers do not in the least call in question the reality of the powers of the hazel-fork, but learnedly discuss whether they are due to natural or to diabolic agency. When in the last century the phenomena of electricity and magnetism became objects of scientific study, but had not yet been comprehended under the grasp of law, it was natural that those of the divining-rod should be referred to agencies so convenient, which seemed ready to account for anything otherwise unaccountable. But, since physicists and physiologists have come to agree that the moving power is furnished by nothing else than the muscles of the diviner, the only question that remains is, What calls forth its exercise? And the conclusive evidence I have given you that the definite oscillations of suspended bodies depend on involuntary movements unconsciously determined by states of *expectancy*, clearly points to the conclusion that we have in the supposed mystery of the divining-rod only another case of the same kind. It is well known that persons who are conversant with the geological structure of a district are often able to indicate with considerable certainty in what spot, and at what depth, water will be found; and men of less scientific knowledge, but of considerable practical experience, frequently arrive at a true conclusion on this point, without being able to assign reasons for their opinions. Exactly the same may be said in regard to the mineral structure of a mining-district; the course of a metallic vein being often correctly indicated by the shrewd guess of an observant workman, where the scientific reasoning of the mining-engineer altogether fails. It is an

experience we are continually encountering in other walks of life, that particular persons are guided, some apparently by an original and others by an acquired intuition, to conclusions for which they can give no adequate reasons, but which subsequent events prove to have been correct; and I look upon the divining-rod in its various applications as only a peculiar method of giving expression to results worked out by an automatic process of this kind, even before they rise to distinct mental consciousness. Various other methods of divination that seem to be practised in perfectly good faith—such, for example, as the Bible and key test, used for the discovery of stolen property—are probably to be attributed to the same agency; the cerebral traces of past occurrences supplying materials for the automatic evolution of a result (as they unquestionably do in dreams) when the occurrences themselves have been forgotten.

Many of the cases of so-called thought-reading are clearly of the same kind; the communication being made by unconscious muscular action on the part of one person, and automatically interpreted by the other—as in the following instance: Several persons being assembled, one of them leaves the room, and during his[1] absence some object is hidden. On the absentee's reëntrance, two persons, who know the hiding-place, stand one on either side of him, and establish some personal contact with him; one method being for each to place a finger on his shoulder, and another for each to place a hand on his body, one on the front and the other on the back. He walks about the room between the two, and generally succeeds before long in finding the hidden object; being led toward it (as careful observation and experiment have fully proved) by the involuntary muscular action of his unconscious guides, one or the other of them pressing more heavily when the object is on his side, and the finder as involuntarily turning toward that side.

These and other curious results of recent inquiry, while strictly conformable to physiological principles, greatly extend our knowledge of the modes in which states of mind express themselves unconsciously and involuntarily in muscular action; and I dwell on them the more because they seem to me to afford the key (as I shall explain in my next lecture) to some of these phenomena of spiritualistic divination, which have been most perplexing to many who have come in contact with them, without being disposed to accept the spiritualistic interpretation of them.—*Fraser's Magazine.*

[1] The experiment succeeds equally well, or perhaps better, with ladies.

ON THE DISTRIBUTION OF STANDARD TIME IN THE UNITED STATES.

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FOR the ordinary purposes of life in a state of society which is not yet complex, a very simple system of recording the lapse of time is sufficient. Sunrise and sunset are local phenomena, which from the earliest times forced themselves upon the attention of every one, and which throughout the early centuries sufficed for the division of time. A further division of the duration of the day (as defined by the continuance of sunlight) was obtained by noting the time of *noon*, and there is no historic period known in which the method of obtaining a rough approximation to this instant by means of the shadow of a vertical rod or pillar was not understood. Probably the observation of such a *gnomon* or *style* constituted the first step in *astronomy of precision*, as distinguished from that astronomy in which numbers do not play the most important part. The instant so determined is technically called the instant of *apparent noon* at any place, and it marks the moment when the sun is highest above the horizon and on the meridian.[1]

Until within a hundred years this apparent time, that is the time marked by the angular distance of the sun from the meridian of any place, was the system universally adopted. A watch should mark $12^h\ 0^m\ 0^s$ when the sun was highest. But the lengths of apparent solar days, or the time elapsed between two successive apparent noons, are not equal at different parts of the year, since the true sun does not move in a plane perpendicular to the earth's rotation axis (the *equator*), but in the *ecliptic*, a plane greatly inclined to the *equator*, and since the sun's motion in the ecliptic is not uniform. Hence arises an inequality in these apparent solar days, and a capital advance was made by the adoption of *mean solar time*, which is now universal. Local *mean noon* is the time when an imaginary sun supposed to move uniformly in the equator is on the meridian of any place, as New York, and a mean solar day is the interval between two successive mean noons. This is divided into twenty-four hours, and these again into minutes and seconds, and the length of these units is practically invariable.

The time of mean noon differs from the instant of apparent noon no less than sixteen minutes at certain times in the year, being some-

[1] Rigorously, the sun may not have its *maximum* altitude on the meridian, but its maximum altitude can never differ from its meridian altitude by more than half a second of arc.

times in advance of it, and sometimes later; so that the moment when the sun was highest at a certain place does not mark a determinate instant unless the day of the year is also given.

It is necessary to remember this, and to insist somewhat upon it, as the idea that the local noon as determined by clocks and watches is a sort of naturally determined epoch is widely spread, while the fact is that it is an artificial epoch, which can only be fixed by a somewhat difficult astronomical observation and a subsequent computation. The farm-laborer who eats his dinner in the field at the time that shadows cast by the sun point north and south is the victim of his own ignorance, as he sometimes anticipates the noon of watches and clocks by more than a quarter of an hour, and is sometimes equally in retard. The improvement of the balance-watch upon the *clepsydra* or the hour-glass and other early time-keepers caused the change to be made from apparent to mean time, and the increasing requirements of a complex civilization demand more and more attention to the keeping of accurate standard time. One of the most important functions of observatories is the determination of such a standard of time, and if this were their sole function the expense of maintaining them would be fully repaid.

If the standard time is important to the man of business in making his appointments and regulating his affairs, to the traveler in providing railways with a correct time by which to govern the movements of trains, and in general to every citizen in his daily occupations on land, it is vital to the successful and safe navigation of the ocean. Every ship that sails for a foreign port must before her departure know the *correction* of her chronometers to Greenwich time (that is, the number of seconds they are *fast* or *slow* on that time), and besides this their *rate* (or the number of seconds they daily gain or lose). Provided with good chronometers and with these data well determined, a ship sails from her port with the power of determining on any day her position on the earth's surface.

A simple observation of the altitude of the sun at noon gives, by a short computation, her latitude, and a determination of the angular distance of the sun east or west of her meridian gives the local time. The difference of the local time of the ship and the Greenwich time, as shown by her chronometers, gives her longitude. Latitude and longitude being known, her place on the chart can be put down with but little uncertainty. This is daily done, if possible, on every one of the ships sailing out of New York City, and on the skill of her officers, the goodness of her chronometers, and the accuracy of their rates, depends the safety of her passengers and cargo. To all men of business, then, in their appointments and affairs on shore and in their commercial ventures by sea, the fact that a standard time is easily attainable and perfectly correct is of no slight importance. To travelers, whether by sea or land, it is truly a matter of life and

death. The watches of railway employés are usually set by one clock, but a difference of one or two minutes on a crowded road may bring about the most fatal results, as the reports of the various railway commissions will show. If a ship leaves New York supposing her chronometer which is regulated to Greenwich time to be losing two seconds a day, while it is really losing six, every day she is really about a mile farther west than her reckoning shows her to be, and in a voyage of a month she will suppose herself to be too far west by thirty miles. Such a result may be attended with the most disastrous consequences, and that it does not oftener so result is due to the skill and watchfulness of sea-captains, a class of men whose vigilance and faithfulness are too little appreciated.

That such accidents do occur is brought constantly before us, in the reports of marine disasters as given in the newspapers and elsewhere, and every year a large volume is published by the English Government—the "Report of Wrecks and Casualties," etc.—in which the details are given. A simple inspection of the wreck-chart appended to this bulky annual volume, where every vessel wrecked during the year has the place of her loss indicated by a dot on the map, shows how frequent such losses are. I know of no simpler way of presenting the risks run, when the actual wreck is not incurred, than by giving the following table from the report for 1863 of Mr. Hartnup, Director of the Observatory of Liverpool, an observatory founded especially for the care of the chronometers of merchant-ships.

The work of this observatory has been continued for many years, and a large mass of statistics concerning the running of the chronometers of ships sailing out of Liverpool has been accumulated and partially discussed.

In the earlier history of the observatory, its attention was confined to the *rating* of chronometers, and, when any chronometer was sent to a ship with a given *correction* and *rate*, a record was kept of the fact.

On the return of the chronometer to Liverpool every effort was made to find the *correction* and *rate* which were given at the foreign port to which the ship was bound, and in this way a vast amount of statistical information concerning the running of the chronometers of merchant-ships out of Liverpool was accumulated.

In the following table, which summarizes these statistics, the *first* horizontal column contains the length of the voyage in months; the *second*, the average error of longitude in geographical miles on the equator, deduced from the means of 1,700 chronometers; and the remaining columns show the average error of the best ten instruments in one hundred, of the second best ten, etc. I have only taken so much of the table as would include a voyage of four months, since a vessel could hardly be without means of correcting her chronometer for a much longer time than this. We may fairly say that this table

represents the danger which the merchant-ships of Liverpool actually were subjected to for many years on account of erroneous running of their chronometers, and because the sea-rates varied from the shore-rates. It must also be remembered that from this table all cases of vessels which were shipwrecked (on this and other accounts) are omitted, so that, no matter how impossible it may at first sight seem to be that such enormous errors existed, it is yet a matter of fact that the errors are *under* and not *over stated.*

Table showing Error of Longitude in Geographical Miles on the Equator, deduced from 1,700 *Chronometers.*

LENGTH OF VOYAGE.	One Month.	Two Months.	Three Months.	Four Months.
Average error from 1,700 chronometers	6	14	23	33
Average error from the best 10 in 100	0	0	1	1
Average error from the second best 10 in 100	1	2	3	4
Average error from the third best 10 in 100	1	4	6	8
Average error from the fourth best 10 in 100	2	5	9	13
Average error from the fifth best 10 in 100	3	7	12	17
Average error from the sixth best 10 in 100	4	9	15	22
Average error from the seventh best 10 in 100	5	11	18	28
Average error from the eighth best 10 in 100	7	15	25	36
Average error from the ninth best 10 in 100	9	24	41	61
Average error from the worst 10 in 100	25	62	101	143

Examining the table in detail, it becomes necessary to recollect that it is a matter of record that these actually were the errors of chronometers carried on a large number of ships sailing out of Liverpool. The average errors derived from no less than 1,700 chronometers are enormous, being as great as thirty-three miles for a voyage of four months.

Among the many vessels carrying these instruments were a large number going on long voyages to India, Australia, and South America, and in many cases these vessels would necessarily be between three and four months or more on the voyage, often without sighting land. It appears from this table that the average error to be *expected* on such a voyage, and with such chronometers as they had (up to 1863), was no less than thirty-three miles! It is plain that no such errors are to be found in the chronometers used by our own naval vessels, nor were American merchant-vessels during the same period so badly provided for, but it is certain that English vessels were provided on the whole with extremely poor instruments.

It is plain that several causes were here acting. The chronometers furnished to these ships were on the average very poor. This fault

could be remedied by a board of inspection appointed by the insurance companies, which should refuse to insure the cargo or hull of any sea-going ship unless her chronometers were found, after trial, to be satisfactory. Part of the error is undoubtedly due to the bad navigation of the captain, who, in distant ports not provided with time from an astronomical observatory, determined the error of his chronometer himself, and that not always correctly. But the great source of error was the fact that the *rate* of the chronometer assigned at the port of sailing did not serve throughout the voyage.

It will be then of some interest to describe the measures now taking in the United States to provide the sea-going ships sailing from our various ports with an accurate standard time; and, further, to explain the facilities offered by the United States Naval Observatory to railways, manufactories, and others, in the providing of a time by which to regulate their affairs.

The Superintendent of the Naval Observatory, the late Rear-Admiral C. H. Davis, some time ago proposed to the authorities of the Western Union Telegraph Company the erection of a large time-ball upon their new building on Broadway, near the City Hall. This time-ball it was proposed to drop daily by telegraph at New York noon. It is to be dropped exactly at $11^h\ 47^m\ 49.53^s$ A. M. of Washington local time, which is New York noon, $12^h\ 0^m\ 0.00^s$, or $4^h\ 56^m\ 1.65^s$ of Greenwich time. It will thus be available both for the citizens, railways, etc., of New York, and for the ships sailing from port It is to be mounted upon the large iron flagstaff on top of the east tower of the Western Union building, the base of the staff being about 230 feet above the street, and the ball being dropped from a part of the staff about 25 feet above this. The whole expense of the apparatus, which is considerable, and the management of it, which requires the attention of a laborer and of a skilled electrician, have been assumed in a public-spirited manner by the Western Union Telegraph Company, for the benefit of the citizens and the shipping of New York City.

The apparatus employed may be briefly described as follows:

Around the iron mast, which is of great strength, is fastened an iron jacket, sliding up and down freely upon it. On this is fitted a ball three feet six inches in diameter, made of copper-wire netting, and painted black. The interstices of the netting allow of a free passage of the wind through the ball, so that less strain is exerted upon the mast, and a larger ball is permissible than there otherwise would be.

At the bottom of the jacket are a coiled spring and a buffer encircling the mast, which take the considerable blow of the falling ball. At $11^h\ 55^m$ of New York time, the ball is hoisted half-way or more up the mast, and at $11^h\ 58^m$ it is hoisted completely up, and the halliards are attached at $11^h\ 59^m$ to a lever actuated by an electro-magnet. At exactly noon an electric signal releases the lever, and the ball falls by its own weight.

If by any mischance the ball does not so fall at noon, it is kept up to its place until $12^h\ 5^m\ 0^s$, when it is dropped. To signalize this programme, which may occasionally be necessary, a small flag marked $12^h\ 5^m$ will be at once hoisted, and kept flying till the ball is dropped. A ball of this size can be seen by every vessel lying at the wharves of Brooklyn and New York, either in the North or East River, and by every vessel in the bay, even beyond Quarantine, if the ordinary night-glass is employed.

At the instant of the fall their chronometers should indicate $4^h\ 56^m\ 1.65^s$ (Greenwich time), and the difference between this time and what their chronometers really give is the correction to them. Daily observations of the fall of this ball will give the daily gain or loss of the chronometers; that is, their rates.

A capital advantage will be that such corrections and rates can be determined without removing the chronometer from the ship, so that a fertile source of disturbance which accompanies the carriage of the chronometer to and from the vessel is thus, in future, avoidable. To the citizens of New York and Brooklyn the ball is widely visible. It can be seen on Broadway from Grace Church nearly to the Battery, and a suitable position can be found nearly anywhere in the city from which its face can be observed.

Incidental to this programme, and as an immediate consequence of it, the means of securing an accurate agreement of clocks throughout the city is at hand. The Western Union Company will agree to control electrically other clocks in New York City and vicinity, so that they shall constantly indicate the standard time. One means of doing this is so simple that it deserves mention. Each clock to be so controlled has an attachment contrived so that when its hands arrive at the position $12^h\ 0^m$ M., a small pin is thrown out through a hole in the clock-face just in front of the minute-hand, which is thus held fast at twelve o'clock. The outer end of the hand is held fast, but the axis on which the inner end is placed keeps on turning, so that the clock-train is not interfered with. This is the mechanical arrangement. The practical working of the system is as follows: Each clock is regulated so as to gain from ten to thirty seconds daily; therefore, when its hands reach noon, it is not really noon, but lacks from ten to thirty seconds of it. The pin is protruded, and fastens the minute-hand in its place till it is withdrawn by an electric signal from the regulating or motor clock, and then all the hands start together, and continue to move for twenty-four hours, gaining their ten or twenty seconds in time for a repetition of the process on the next day. This beautiful and simple device, invented by Bain, has another advantage —that of cheapness—for it requires the use of the wire from the controlling clock but for an instant each day, and, in a crowded city like New York, the expense of erecting and maintaining the necessary telegraphic wire from each clock to the controlling clock is a minimum.

Some similar system should be adopted by railways leading out of New York, whose standard clocks could be connected at a trifling expense with the main clock, and kept right to within less than thirty seconds, which is near enough for most purposes. It should not be forgotten that each clock so controlled has the same accuracy as if it were directly controlled by the standard astronomical clock of the Naval Observatory at Washington, since the time which is obtained at that institution is directly distributed throughout the system.

For railways this system is peculiarly advantageous. Most railways adopt the time of one city as the standard time, by which all trains are run, and to which the watches of all employés are adjusted.

Suppose this should not be New York time, but another, as Poughkeepsie time, for example. A simple device, lately proposed by an ingenious writer in the *New York Tribune*, enables the New York clock to be controlled to both times. This consists of a double minute-hand—that is, instead of making a single minute-hand, make it double, with two pointers, so that when one points to New York time, the other points to Poughkeepsie time. The controlling stop, or pin, acts upon the New York minute-hand, but the other hand is equally kept right.

Such a clock will serve to control in its turn all the clocks along the line of the railway by a daily signal, so that at every railway-station the station-master's clock indicates, say, Poughkeepsie time. If required for the benefit of the citizens of each place, a second minute-hand can be added to each of these secondary clocks, so that the local time of each station can be indicated, while at the same time each railway-clock affords the means to each railway-employé of correcting his own watch. This system, so simple in theory, is equally simple in practice, and requires nothing but the care and fidelity of the agents to whom its execution is confided to make it eminently useful and beneficial. It should be remembered, however, that to carry out its provisions carelessly is to commit a positive crime, since so much depends upon its results. Similar systems of control are now provided in many places. The observatory at Washington controls several clocks in the various departments; and in London, Edinburgh, Paris, Vienna, Bern, and elsewhere, this work is successfully carried on.

The distribution of time-signals (either with or without *controlled* clocks) to railways, etc., is a most important matter, in which the United States is far behind England, for example, where about five hundred railway-stations receive a signal daily. This is partly due to the enormous extent of America in longitude, so that very different local times are used at different places of the same continuous railway-line, and partly to the fact that the telegraphs are owned by the Government in England, thus rendering the execution of a general system of time-signals comparatively easy. In the opinion of many experienced and prominent railway-officials in the United States, it is quite

feasible and very desirable for all railways to be operated by one common time, and the first step toward this is plainly the *certainty* that the time-signals which are now regularly sent from the Naval Observatory shall reach each railway-station once daily, at least.

It should be remarked that this change, as well as the changes it would imply, and which would follow as natural consequences, is not by any means so violent as the change from the English system of measures (feet, pounds, bushels, etc.) to the metric system (metres, grammes, litres, etc.) often proposed, and now partially adopted. In the latter case, the *units* are altered, and for the first generation, at least, continual reference will have to be made from the old system to the new; whereas, in the first case, the units remain the same, and the point of reference only is changed. Once familiarize a citizen of Detroit with the fact that his local mean noon is to be called $12^h\ 24^m$ instead of $12^h\ 0^m$, and the transition would hardly be noticed. If by any chance all watches, clocks, and time-keepers in New York City could simultaneously be turned back $12^m\ 10.5^s$ (i. e., to Washington time) unknown to their owners, it is probable that the number of people who would be aware of the change would be extremely small.

Besides sending the signals which regulate the New York clock of the Western Union Telegraph Company, the Naval Observatory at Washington has for several years sent daily (except Sundays) a telegraphic signal at Washington noon over the lines of the Western Union, which signal is already widely distributed.

To increase the usefulness of this signal, Admiral Davis entered into arrangements with the officials of the Western Union Telegraph Company by which they will contract to deliver such a signal daily to subscribers (for a year) at extremely low rates. The company will connect the house, office, or manufactory of the subscriber with its local office (for the present the arrangement is confined to offices in towns having 20,000 inhabitants or over) in his town for a sum to be settled according to the length of wire required, etc., and will furnish him with a telegraphic sounder, or such other form of apparatus as may be suitable.

The price of such a connection is to be settled according to the various circumstances of each case, and each subscriber will of course bear the necessary expense, which will be met in the form of an annual rental. Besides this charge peculiar to each subscriber, the company will charge a certain small sum for transmitting the Washington noon signal to its own office for distribution; and this sum, if there is but one subscriber in any town, must be paid by him. Two subscribers halve the expense, for three each pays one-third, and so on. For New York and other large cities this expense will be almost nothing, so that the real cost of a transmission of the Washington noon signal will practically be the annual rental of the wire used to connect the subscriber's premises with the telegraph-office. By the method of

double hands before described, this Washington noon signal may be used to control a clock by the Bain or some other system in a house, or manufactory, or railway-station, and a general acceptance of Washington (or any other) standard time by which to regulate the running of railway-trains or other affairs is rendered easy and safe if it is desirable to make this change.

The advantages of a general use of this system are very great, and will be evident on a slight consideration. The arrangements proposed by the Naval Observatory are not intended to conflict, and they do not conflict, with others more local adopted and successfully carried on by various observatories.

Among these, the more prominent are the Harvard College Observatory, which, under the direction of the late Prof. Winlock, instituted a system of time-distribution to the various railways of Boston and vicinity, which has been for some years in successful operation; the Allegheny Observatory, of Pittsburg, which, under its director, Prof. Langley, has also for some years furnished standard time to the Pennsylvania and other railways; as well as the observatories of Cincinnati, Albany, and others.

The coöperation of all these institutions will undoubtedly result in providing for a more extensive and better-organized system than has hitherto been possible, and some of the benefits to be derived from such a coöperation have been pointed out. The establishment of time-balls at our various seaports, Boston, Baltimore, Philadelphia, Norfolk,[1] Charleston, Savannah, New Orleans, etc., is most important, and insurance companies, shippers, and owners of vessels, could well afford to bear the small necessary expense, which would be more than repaid to them by the additional safety given to navigation.

The extension of a system such as exists in New York to the various seaports of the country could not but secure a greater safety to sea-going vessels and an increased security to the traveling public, two objects worthy of all attention.

[1] Time guns or balls, at Hampton Roads and the Delaware Breakwater, are peculiarly demanded by commerce, but would have to be supported by underwriters and shippers, as there will be little demand for them from the neighboring population.

A time-gun at Hampton Roads would be used by all vessels proceeding on long voyages from Baltimore, the Potomac, and Richmond, and by the large number of ships calling at Hampton Roads for orders where to carry their cargoes. It would be particularly valuable to ships using this roadstead as a harbor of refuge on their voyages, which ships at present seldom or never wait for fair weather to rate their chronometers, but, on the first appearance of settled weather, slip out to sea to continue their voyages.

MATTER AND MIND.

By FRANCES EMILY WHITE, M. D.

UNDER cover of the words placed at the head of this paper, it is proposed to call attention to a few only of the more salient points involved in the subject, and especially to those suggested in a recent article in this journal,[1] in which the attempt is made to apply the principle of correlation to certain forces (called indifferently mental and spiritual), without recognizing that highly-important factor in the manifestation of all known force, viz., matter.

In examining any subject from what claims to be a scientific point of view, established facts must not be ignored; and in proportion to the importance of the question which science is called upon to answer, should be the exactness of the solution offered.

It has been conclusively shown, by experimental methods similar to those employed in demonstrating other correlations, that emotion and thought are correlated with heat and electricity;[2] and the correlation between *thought* and *mass motion*, through the action of nerve and muscle, is constantly exhibited in the human body. It must, then, be admitted that these forces (thought, etc.), like those with which they are correlated, are manifestations of matter.

The scientist knows of no mode of energy manifested in any other way than through matter; and the supposed "cycle of operations in which there is no annihilation of spiritual force" must be regarded, not as a cycle, but rather as a segment of the great cycle which includes all natural phenomena.

The idea of annihilation either of matter or of force is inadmissible to science; but there is a constant shifting—a disappearing and reappearing—of different modes of energy, corresponding to the unceasing mutations of matter; the special force manifested in any given case depending on the kinds and conditions of the matter involved.

The supposition of other kinds of force, differing from those recognized by the physicist, implies either different kinds of matter, or the same kinds differently conditioned.

The relations of the different parts of an organism to each other, and of the entire organism to its environment (the environment including other organisms, as well as inorganic matter), must all be scrutinized when we attempt to trace the source of the power manifested by any organism. A symphony of Beethoven is made up of bars and interludes—of points and rests—of quavers and semiquavers

[1] "On the Annihilation of the Mind," by Prof. John Trowbridge, POPULAR SCIENCE MONTHLY, April, 1877.

[2] University Series, No. 2, "Correlation of Vital and Physical Forces," by George F. Barker, M. D.

—like any other, even the simplest piece of music. How, then, does it differ from every other musical composition? Among which of its parts shall we look for the grandeur of movement, the rush of harmonies, and the eloquence, more powerful than that of words, which, as it thrills the metallic strings, awakens responsive vibrations among those differently constituted and conditioned strings which form the organ of hearing, and through this organ arouses emotions among the deepest of which our natures are susceptible? It is true, the effects produced are but poorly represented in the symbols of the musical score, or in the strings of the instrument which respond to the performer's touch; these elements are, however, not only important, but absolutely essential to the production of the results, and they must not be ignored in the statement of the problem with which we have to deal. When, however, we attempt to follow the transformations of energy which have taken place between the first and last links of the chain connecting the brain of the composer with that of the listener, we are lost in a maze of hopeless intricacy—hopeless, because we are unable to include in our limited grasp the innumerable threads which together constitute the clew to the labyrinth.

Nevertheless, we are compelled to believe that a clew exists, and that it depends on these twin principles—the *correlation of forces*, and the *inseparableness of force and matter*—since each link in this seemingly endless chain, when separately examined, is found to connect with some form of matter and some kind of force, with both of which we are more or less familiar.

Functions of mind cannot be formulated in terms of matter—there is no correlation in the language employed; but this is equally true of other phenomena—as, for example, of combustion. We know that chemical reaction between carbon and oxygen results in heat-production; and we know that certain combinations of vibrations of musical strings, communicated to the membrana tympani of the human ear, result in the production of emotions. It is safe to promise an explanation of the latter phenomenon, whenever an explanation of the former shall be forthcoming.

The phrase "principle of life" is deceptive; the expression "manifestation of life" means something definite, since life may be regarded as the sum of the forces manifested by certain forms of matter brought into certain relations with each other, and with the environment; but a "principle of life," although it may be talked about, cannot be located nor described; it is a phrase, *et præterea nihil.*

That which is called *the ego*—the sum of the various elements which make up the character—cannot, from a scientific point of view, be regarded as an entity, unless the combined forces and powers of any machine may be so regarded.

When a machine is taken to pieces, or falls into decay, what becomes of the forces previously manifested by it? Have they gone off,

in some associated way, to manifest themselves elsewhere in manufacturing carpets, impelling railroad-trains, or printing newspapers, as determined by the original construction of the machine which they have deserted? This question belongs as legitimately to science as the one discussed in the article previously referred to; for the scientist has no knowledge of mind apart from the brain which manifests it.

The same writer attempts a projection, upon the screen of thought, of "a great source of life and mind, the prototype of our physical sun," which may be supposed to hold the same relation to the world of human thought that the sun holds to our world of matter.

The relations of the sun's heat and light to the energies of our planet (including the forces manifested by the organisms developed from its crust and atmosphere) are correlations, in which the forces concerned are mutually convertible; moreover, the energies displayed by living bodies are of a higher order than are those of the sun (heat, light, etc.) through whose influence these living energies are developed.

Where, then, does such a simile lead? If the forces emanating from this great source of life and mind are convertible into human energies, then—according to the same law—human energies are convertible into those of the prototype. No new principle is introduced by such a conception, and, in order to make the figure good, the forces of the prototype must even be regarded as of a lower order than human energies.

The human brain presents the most complex and highly-organized form of matter known. Its relations and means of communication with the other less complex organs which make up the entire body are most subtile and intimate; through the organs of the special senses it is also brought into communication with an environment limited only by the range of vision, which is extended, by telescope and microscope, to the nebulosities which belong to immensity on the one hand, and to the obscurities of the infinitesimal on the other.

The energies displayed by this remarkable organ hold a rank among known forces comparable, in range and complexity, to its structural superiority over other forms and combinations of matter. These forces, so far as they come within the range of scientific observation, hold the same sort of relation to the material organism that the force called magnetism bears to the magnet, or heat to the body from which it emanates.

Beyond this relation, Science has no testimony to offer.

GAR-PIKES, OLD AND YOUNG.

By Professor BURT G. WILDER,
of cornell university.

II.

THE writer's opportunities for observing the motions of the adult gar were too brief to enable him to describe them accurately. It is to be hoped that this fish may soon be placed in some public aquarium. But the motions of several young gars were carefully watched daily during three weeks.

The movements of the little gars, even the smallest, were very unlike those of the common little fishes, minnows or catfishes, which were placed with them. These latter seemed agitated, and splashed about in an indeterminate way. But the little gars, though they went like arrows when disturbed, usually remained almost at rest, or moved slowly about with a dignified, almost solemn air, as if conscious of very ancient and honorable lineage. They also have, as was remarked by Prof. Agassiz, the power of moving the head upon the neck; and occasionally the whole body was thrown into two or three undulations, resembling those of a short serpent; and so impressive is the air of supercilious self-possession that one might almost imagine them shrugging their shoulders at other creatures, including the bipeds of recent creation, who study their movements.

To sounds in general they paid no attention. But a tap upon the side of the vessel usually caused them to start and open the mouth, sometimes two or three times in succession.

It has already been said that the little gar first taken was recognized as such; yet the resemblance to the adult was mostly in the general elongated form of the body, and in several other respects there were marked differences. First, in *color*. The old gar is a bluish ash-color, or light gray; darker above, and lighter below, but with no distinct patches. All of the young gars presented a distinct though irregular dark stripe along the side of the body and head, crossing the eye. The belly, too, was almost white, and strongly contrasted with the darker regions.

Second, the smallest ones had *no scales* at all; but with one, 108 millimetres (about four and a quarter inches) long, the hinder half of the body showed outlines of the scales in process of formation, and the larger ones had the armor more or less fully developed. At about the same time the upper and lower borders of the tail become protected by several pair of pointed plates, the *fulcra*.

The third and most striking peculiarity of the young gars con-

sisted in the existence of *two tails*, an upper and a lower. These are shown in Fig. 8, *B*.

The formation of these two tails, and their significance, will be considered further on; for the present, we are concerned with their structure, their relative position, and their uses. The lower tail was

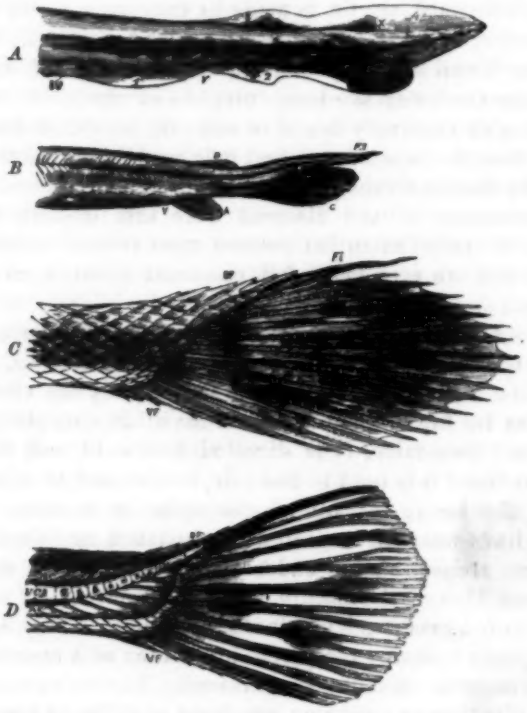

FIG. 8.—FOUR FIGURES OF THE TAILS OF *Lepidosteus* AT DIFFERENT STAGES.

A, from a specimen twenty-two millimetres or seven-eighths inch long, enlarged four diameters. The ventral fin (*Ve*) is just appearing. The median fin is being absorbed between the four spots referred to in Fig. 9. The tip of the tail is inclined upward, and the infra-caudal lobe is larger. In *B* the primordial fin has almost disappeared; the dorsal (*D*) and the anal (*A*) fins are quite large. The infra-caudal lobe is nearly as long as the tip of the original tail, which has been reduced to a slender vibratile filament. This specimen is forty-four millimetres or one and three-fourths inch long, and the tail is enlarged two diameters. *C* shows the tail of a specimen three hundred millimetres or nearly twelve inches long, of natural size. The filament is still further reduced, and the rays of the infra-caudal lobe form the end of the tail. In *D* the tail is that of an adult, one-half natural diameter. The filament, the original end of the body, has wholly disappeared, and the infra-caudal lobe forms the tail. But dissection shows the spinal axis extending along the dorsal border to a point corresponding with the previous attachment of the filament. (Further description and discussion of these changes, with references to authors, may be found in a paper by the author, entitled "Notes on the North American Ganoids," "Proceedings of the American Association for the Advancement of Science," 1875, pp. 151-193.)

evidently the caudal fin. It had several rays, and a rounded hinder border. But it was smaller in proportion than in the adult gar, and the middle rays were directed obliquely downward, instead of horizontally backward.

The upper tail is best described as a single fleshy filament, flat-

tened from side to side, and tapering to a fine extremity. In the smallest gars it was longer than the fin below, in the older it was shorter, while in the adults no trace of it appears.

These two tails have very different movements. The lower, corresponding to the caudal fin of the ordinary fish, is used in three ways. When the little gar is in a gentle current, and wishes not to be carried downward, the fin is made to execute a series of undulatory movements, such as have been described by Prof. Agassiz respecting the dorsal fins of young pipe-fishes, etc., and such as the writer has observed with the long dorsal fin of *Amia*.

This tail is also strongly flexed to one side, as with ordinary fishes, in order to change the course. And it is rapidly moved from side to side for all sudden and rapid locomotion, as when frightened.

The movements of the filament were first described by Prof. Agassiz, and he called attention to them upon several occasions. But his descriptions are very brief, and, upon one point, seem to require modification.

The filament is in almost constant vibration. Occasionally, when the gar is at rest, and perhaps also when it is turning, or rapidly swimming, the filament is not used. But usually the vibrations are so rapid that the tip of the filament is invisible, excepting as an indistinct blur. Generally, it is directed backward and slightly upward, but at times it is bent to one side, or elevated to nearly a right angle with the body, the tip all the while in constant vibration. Those who have watched the tail of an irritated rattlesnake, or even of a common striped snake, under strong excitement, may form a pretty correct idea of the nature of this movement. It was characterized by Prof. Agassiz as "involuntary;" and so it may be regarded, since its rapidity is such as to preclude the idea of a separate volition for each movement. But the gar, evidently, has entire control of the vibrations; for they are more or less rapid at different times, and are occasionally intermitted; the position of the whole filament is changed at will; finally, the muscular bands upon each side of the cartilaginous rod, which runs through the filament, consist of the striped variety of muscular fibre, as are the other voluntary muscles.

This is all the writer has seen of living young gar-pikes. But the explanation of the peculiar double tail is furnished by some still younger specimens, the smallest of which is shown, enlarged, in Fig. 9.

These little gars were scooped out of the Red River, near Shreveport, Louisiana, in the spring of 1871, by a lad only ten years old, who had heard the writer say that he wished for very *small* fishes. At that point these young gars were then as abundant as minnows, as easy to catch, and commercially as worthless. All of them are less than two inches long, and among them are two about three-fourths of an inch in length. These last are not only much smaller than any

previously examined by naturalists (so far as known to the writer), but they also furnish the clew to the double tail, and suggest some important paleontological considerations.

While earnestly expressing his appreciation of the value of these little gars, the writer finds himself compelled to exemplify the proverbially ungrateful and dissatisfied nature of zoölogists by regretting that there were not more of them, and that some were not very much smaller, or even still within the egg.

In this connection one is reminded that now, as a rule, the smallest rather than the largest are desired by naturalists. The giants are curiosities, and interesting as showing the capacity for *growth;* but the mysteries of development, the relations of apparently diverse forms, and the order of geological succession, are best revealed by the apparently most insignificant.

A good illustration of this inverse ratio between size and value is contained in the following passage from Prof. and Mrs. Agassiz's "Journey in Brazil:"

"Mr. Agassiz has a corps of little boys engaged in catching the tiniest fishes, so insignificant in size that the regular fishermen, who can never be made to understand that a fish which is not good to eat can serve any useful purpose, always throw them away. Nevertheless, these are among the most instructive specimens for the ichthyologist, because they often reveal the relations not only between parent and offspring, but wider relations between groups."

Of the two smallest gars, one is nearly colorless, while the other is marked very much as are the older ones. They are 18 millimetres (a little less than three-fourths of an inch) in length. The head is short and flattened, with slight indications of teeth on the edges of the jaws. With one of them the ventral fins have not appeared; with the other they are represented by minute white elevations. Each pectoral consists of a fleshy lobe, surrounded by a thin fringe or border.

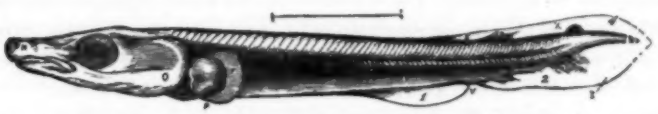

FIG. 9.—SMALLEST GAR-PIKE YET OBTAINED (EIGHTEEN MILLIMETRES OR ABOUT THREE-FOURTH INCH LONG, ENLARGED FIVE DIAMETERS).

The actual length is indicated by the line above the figure. There are no scales. The head is short. The pectoral fin (*P*) consists of a fleshy lobe (*L*), with a thin fringe or border (*F*). The ventral fins have not appeared. A median fin extends along the hinder third of the body above and the hinder half below. It is interrupted by the vent (*V*), and presents four darker and more or less differentiated spots. The anterior pair are evidently the beginnings of the dorsal (*D*) and anal fins. The signification of the hinder dorsal spot is uncertain. But the hinder spot below (*C*) presents rays, and is the commencement of the infra-caudal lobe.

The hinder end of the body tapers to a point, as with *Amphioxus*, the extremity being slightly bent downward. At the junction of the middle with the hinder third of the body commences a delicate median fin, colorless, and without rays for the most part, and extend-

ing around the tip of the tail forward to the vent, thence forward to about the middle of the body. Such a primordial median fin exists in the young of all fishes whose development has been studied. The permanent fins seem to result from the formation of cartilaginous or bony rays either throughout most or the whole of its length, as with lampreys and common eels; or at several points, as with the mackerel and *Polypterus;* or at three, or two, or only one, as with the cod, the blue-fish, and the pickerel. The intervening portions disappear. The hinder part of the primordial fin of the smallest gars presents four points of darker coloration, two above and two below. The posterior upper spot presents no rays, and later seems to disappear.[1] The other three are evidently the beginnings of fins. The anterior above and that below occupy the positions of the future dorsal and anal fins. The destiny of the hinder lower spot is better seen by comparison with larger examples.

The series given in Figs. 8 and 9 shows that, as the gar increases in length, the primordial fin disappears, the dorsal and anal increase, and the end of the tail becomes more slender and pointed. But the most striking change consists in the enlargement of the hinder lower spot into what may be called the infra-caudal lobe. The rays of this become longer and more numerous. They project beyond the margin of the primordial fin, so as to leave a decided notch, as in Fig. 8, *A*.

In Fig. 8, *B*, the end of the body merits the name of filament, and the relative size of it and the lobe is reversed. Afterward, partly by more rapid increase of the lobe, and partly by absorption of the filament, the latter seems smaller and smaller, and at last disappears; so that the lobe, from having been at first an outgrowth from the filament, finally becomes the whole of the tail or caudal fin.

It appears, then, that the hinder end of the body undergoes considerable change before reaching the adult condition. Aside from the partial disappearance of the primordial median fin and the gradual development of the ventrals, the dorsals, and the anal, the caudal fin assumes at least three distinct forms. The first is lance-shaped and simple, like that of *Amphioxus*, the eel, the lamprey, salamanders, and tadpoles. The second is compound, with a slender filament above and a broader fin below, as with some sturgeons and sharks. The third consists entirely of the lower fin, which is enlarged and brought into a direct line with the body, the longest rays being a little above the middle. Its upper and lower borders are now thicker and stronger than the intermediate portions; whereas in the first stage the cartilage and muscle are in the centre, the upper and lower borders being very thin.

In short, the tail of the gar-pike undergoes a decided *transformation*. And one naturally inquires, "What is the occasion for it?"

[1] It may have a morphological significance, as suggested further on respecting the fossil *Glyptolæmus*.

It is so recently that all structural differences and changes were supposed to be readily explicable upon the doctrine of final causes, that we naturally turn first in that direction. Some transformations certainly seem to relate very distinctly to the welfare of the individual, as when the caterpillar becomes a butterfly, and when the aquatic larvæ of mosquito and dragon-fly change their forms with their habits and modes of life. So, among the vertebrates, it is obvious that the tadpole is by no means adapted to the necessities of the frog and the toad; and the intermediate stages, resulting from the gradual loss of the tail and the acquisition of legs, while perhaps not particularly suited to either aquatic or terrestrial locomotion, seem to be required in order to permit the development of the lungs and the accompanying disappearance of the gills.

But can the transformations of the gar-pike's tail be thus accounted for? According to present knowledge and justifiable inference, the *Lepidosteus* not only passes the whole of its life in the water, but is also, from first to last, an active, predaceous fish, requiring all possible advantages of form and fin in order to overtake its prey.

Since no marked change occurs in the general form of the body, we may perhaps assume that it is perfectly well adapted to the fish's needs; although this suggests the general inquiry as to the *cui bono* of the almost infinite variations from the ideal form supposed to be best suited to aquatic locomotion.

But do we know, or can we easily infer, any differences in the necessities or the manner of life of the *Lepidosteus* at different ages, which may account for its having a tail first like a lamprey's, then like a sturgeon's, and, finally, like that of *Amia?*

It may be suggested that the rapid and, at most, invisible vibrations of the filament enable the young gar to glide stealthily upon its prey. But the very young would seem to be even more in need of such precaution, and with them the tail is relatively as large as in the adult, although differently shaped. Finally, even if we conclude that the three distinct stages of the tail are perfectly adapted to certain hypothetically unlike necessities, what shall be said of the intermediate conditions? While growing, the infra-caudal lobe must be rather a hinderance than a help to the movements of the primitive tail; and while disappearing, the filament, being useless, must be, if anything, an incumbrance.

Shall we, then, conclude that these changes in the appearance of a single individual are for the sake of *variety*—as some would explain the great diversity of specific form and coloration among animals and plants?

At the present day, neither of the explanations above given is likely to wholly satisfy the large class of thinkers who, whether or not they accept any particular evolution doctrine, are inclined to believe that there is, in many cases, a more or less exact parallelism between

the changes which occur in the development of an individual, the successive forms of geological times, and the series of living forms, lower and higher, or more generalized and more specialized.

In the smallest gar here described, and presumably in still younger examples, the axis of the body, represented by the notochord or primitive vertebral column, is nearly horizontal, about midway between the upper and the lower borders of the tail. This is likewise the case with the lowest known vertebrate, *Amphioxus;* with the forms next above, the hag-fishes (*Myxine* and *Bdellostoma*) and lamprey-eels (*Petromyzon*); with the larvæ (tadpoles) of frogs and toads; and with the adults of the aquatic and tadpole-like salamanders, *Menopoma* and *Menobranchus*.

Finally, such a tail exists in the Dipnoans, or mud-fishes, of Africa, South America, and Australia (*Protopterus*, *Lepidosiren*, and *Ceratodus*), which have some striking affinities with Batrachians, but are usually regarded as fishes, and are, perhaps, the best illustration of *generalized* forms.

To this variety of tail, Cope has applied the name *isocercal;* Huxley calls it *diphycercal*, and gives as an example *Polypterus*, where, however (as in *Calamoichthys*), the "end of the notochord is hardly at all bent up." Wyman, finding this kind of tail in the embryo of a skate, called it *protocercal*, and, on some accounts, this seems the more suitable name.

As the gars grow older, the relative length of the filament and the infra-caudal lobe constantly changes. At first the former is the longer; in a specimen 108 millimetres long, their tips coincide; in one 142 millimetres long, the lobe projects beyond the filament; and in a third, 300 millimetres long, the filament is much the shorter, is ragged and attenuated, and during life was rarely employed. This second stage, or rather series of stages, has several counterparts among living Selachians and Ganoids. The most accurate resemblance is presented by the shovel-nosed sturgeon of the Mississippi River (*Scaphyrhynchus*). The filament is excessively elongated in *Chimera*, and exaggerated as to both length and breadth in the thrashing-shark (*Alopias*). But, with many sharks, the common sturgeons, and the spoonbill (*Polyodon*), the size of the infra-caudal lobe is so nearly that of the filament as to give the whole tail a nearly symmetrical outline, and lead zoölogists to speak of the "upper lobe," whereas it is really the bent-up end of the body. This kind of tail is called *heterocercal.*

The gars above mentioned are supposed to be the young of the *Lepidosteus osseus.* Just at what size the filament wholly disappears in that species is not known. But with the smaller and proportionally shorter species, *L. platystomus*, there is no sign of the filament when eighteen inches in length. The tail might then be thought, at first sight, to be symmetrical. But the longest rays are a little above the

middle, and dissection shows that the spinal axis is continued backward and upward as a cartilaginous rod,[1] terminating at the upper border, just under the hinder pair of *fulcra*, and at the point where the filament was attached. The rays are all attached to the lower border of the spine; and there is only a lower lobe of the tail.

A similar structure exists in the tail of *Amia*, which Prof. Huxley gives as an example of *heterocercal* tail. It seems better, however, to discriminate between it and the previous stage, where the upper lobe (filament) exists, and it may, therefore, provisionally be called the *masked heterocercal*, or perhaps the pseudo-homocercal.

Prof. Huxley has more recently given figures and descriptions of the tail of embryo Teleosts (*Gasterosteus*), in which the structure is nearly identical with that of the adult *Amia* and *Lepidosteus*.[2]

A. Protocercal. First stage of *Lepidosteus*. Permanent in *Amphioxus*, *Petromyzon*, *Lepidosiren*, *Polypterus*. Also in some ancient Ganoids, as *Glyptolæmus*.

B and *C*. Heterocercal. In the sturgeons, and most sharks, and many mesozoic fossils.

D. Not represented, so far as I know, among recent or fossil forms.

E. Masked heterocercal. In adult *Amia* and *Lepidosteus*. In the embryo of many Teleosts. In *Megalurus* and some other fossils of Mesozoic and more recent epochs.

FIG. 10.—DIAGRAMS INTENDED TO ILLUSTRATE THE CORRESPONDENCE OF THE SUCCESSIVE STAGES OF TRANSFORMATION OF THE TAIL OF *Lepidosteus*, WITH THE TAILS OF CERTAIN LIVING FORMS MORE AND LESS GENERALIZED, AND OF CERTAIN FOSSILS MORE AND LESS ANCIENT.

A, the first or *protocercal* stage, where the end of the vertebral column (*Vc*) is horizontal and divides the tail into upper and lower lobes nearly equal in size. *B* and *C*, the heterocercal stage, where the original tail is more or less elevated by the lower or infra-caudal lobe (*IC*), and becomes the filament (*Fi*), usually called the "upper lobe." In *D* the infra-caudal lobe is longer than the filament, and in *E* the latter has wholly disappeared, and the tail assumes the last or "masked heterocercal" condition.

The same author concludes that in many adult Teleosts the posterior end of the spine is more or less strongly bent up, although the tail is outwardly nearly or quite symmetrical.

[1] This rod consists of the notochord, and a slender prolongation of the spinal cord, surrounded by a cartilaginous sheath.

[2] The writer has found the same condition in newly-hatched catfishes (*Amiurus*), and it has been observed in the embryo of a species of *Cottus*, by Mr. S. H. Gage, a student of natural history at Cornell University.

But when, as in the majority of species, the hinder border is emarginate, so as to form an upper and a lower lobe, the former is never known to contain any extension of the spine; although some South American Goniodonts have the upper ray prolonged into a sort of filament, yet in other forms the lower ray is similarly elongated, and neither can be compared with the true filament of the young gar or the upper lobe of sturgeons and sharks.

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But among the earliest known fossil fishes are some in which the end of the spine is not at all bent up; the tail is protocercal. And, with two genera (*Glyptolæmus* and *Gyroptychius*) described by Prof. Huxley, it may be possible to determine the correspondence between the two dorsals and anals and the two pair of differentiated spots upon the primordial median fin of the youngest *Lepidosteus*.

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The fact is, however, that the so-called Ganoids occupy a very peculiar position. None of them can be touched without affecting the entire series of fish-like forms. Ichthyology is in a state of instability, and every important new fact, every decided expression of opinion by high authority respecting the Ganoids is liable to require a revision of all our ideas.

To present even an outline of the many views, and of the facts and considerations upon which they are based, would require an entire article, with many figures and some anatomical description.

To the reader who has become interested by the foregoing imperfect sketch of the gar-pike, and who has the good fortune to live within reach of it, of *Amia*, and of the sturgeons, the writer would earnestly recommend a careful and systematic investigation of their habits and their structure—especially that of the brain—and of their development, as likely to furnish the most reliable basis for their classification.

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We may then naturally suppose that those materials which are advantageous for the building of our habitations must stand in somewhat the same relations to air, water, and heat, as the materials we use for our clothing. Walls allow air to pass through them, and they must do so to a certain degree, if we are to preserve our health within them with some comfort, and without injury. Current opinion is certainly opposed to my assertion about the permeability of walls to air, even more so than to that about the permeability of our clothing; but it is easy to show that current opinion labors under an error which has no other basis than the insensibility of our senses to the movement of the air, if the same is less than nineteen inches per second. This is the cause of the fallacy that no motion of the air takes place. Just as well might we deny the earth's rotation round its axis at the rate of more than a quarter of a mile per second, because we are not in the least aware of this tremendous velocity. Only very late and slowly have our minds opened to the conviction that after all the earth moves round the sun, and not the sun round the earth, and that our eyes had all the while been mistaken. There must exist something of a higher nature, of a greater power, than our sensuous perceptions, and that is science, which examines and probes our perceptions. Science has not the least power over Nature; she cannot command any alteration in Nature, cannot give it any laws—

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she can only recognize the laws of Nature. But science changes the notions of man, and often reverses them. Ideas and notions based on science enrich us, partly directly, partly indirectly, with new means of making use of natural laws. It was not till astronomy had found and determined celestial mechanics that the human mind was enabled to begin that development of the mechanical element which is the pride and the power of our period as compared with former times.

If, then, we are hopefully satisfied with endeavoring to increase our insight, our science of the things that are, the benefit will not fail to come, and everything is beneficial of which man learns to make use. This requires time—often a very long time—as old experience teaches.

The task of science is to lay hold of everything perceptible, and to penetrate it—the small as well as the great. The insect and its life is just as interesting to science as the elephant, and therefore I believe that I may occupy myself with that air which flows through our walls, although its motion is not recognized by our sensations.

We may conclude from many facts that walls are permeable to air. No one maintains that houses have water-tight walls, and everybody knows that masonry is easily penetrated by water. Wherever a wall is in perpetual contact with water, it becomes so soaked that at last water comes out in drops on the other side. Certainly, where water can pass, air must pass much more easily, because air is seven hundred and seventy times more light and movable than water. It is very easy to construct water-tight apparatuses and vessels, but very difficult to make them air-tight. Still people are surprised when they hear of a change of the air through a wall; they see, of course, and feel the water in the wall, but of the air in it their senses have no direct perception.

But we have means to demonstrate to our senses the passage of air through our building-materials; we have only to lead the air which comes against some large surface of wall into and through a narrow tube. I will prove this to you by experiments; but you have often seen the same thing before, when you were looking at some piece of water which had some small in- and outflow. These may be in lively motion and driving mills, but on the whole surface the water seems to be completely at rest. But, if we do not see any water running in and out, we declare the whole to be stagnant, and we may be very much mistaken.

I have here a cylindrical piece of mortar, half lime, half sand, five inches by one and two-thirds. The cylinder has been covered all over with melted wax, which is impermeable to air, with the exception of its two circular ends. You see this glass funnel with a tube. I fix it on

the changes which occur in the development of an individual, the successive forms of geological times, and the series of living forms, lower and higher, or more generalized and more specialized.

In the smallest gar here described, and presumably in still younger examples, the axis of the body, represented by the notochord or primitive vertebral column, is nearly horizontal, about midway between the upper and the lower borders of the tail. This is likewise the case with the lowest known vertebrate, *Amphioxus;* with the forms next above, the hag-fishes (*Myxine* and *Bdellostoma*) and lamprey-eels (*Petromyzon*); with the larvæ (tadpoles) of frogs and toads; and with the adults of the aquatic and tadpole-like salamanders, *Menopoma* and *Menobranchus*.

Finally, such a tail exists in the Dipnoans, or mud-fishes, of Africa, South America, and Australia (*Protopterus*, *Lepidosiren*, and *Ceratodus*), which have some striking affinities with Batrachians, but are usually regarded as fishes, and are, perhaps, the best illustration of *generalized* forms.

To this variety of tail, Cope has applied the name *isocercal;* Huxley calls it *diphycercal*, and gives as an example *Polypterus*, where, however (as in *Calamoichthys*), the "end of the notochord is hardly at all bent up." Wyman, finding this kind of tail in the embryo of a skate, called it *protocercal*, and, on some accounts, this seems the more suitable name.

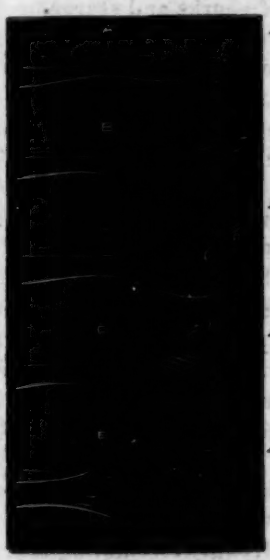
As the gars grow older, the relative length of the filament and the infra-caudal lobe constantly changes. At first the former is the longer; in a specimen 108 millimetres long, their tips coincide; in one 142 millimetres long, the lobe projects beyond the filament; and in a third, 300 millimetres long, the filament is much the shorter, is ragged and attenuated, and during life was rarely employed. This second stage, or rather series of stages, has several counterparts among living Selachians and Ganoids. The most accurate resemblance is presented by the shovel-nosed sturgeon of the Mississippi River (*Scaphyrhynchus*). The filament is excessively elongated in *Chimera*, and exaggerated as to both length and breadth in the thrashing-shark (*Alopias*). But, with many sharks, the common sturgeons, and the spoonbill (*Polyodon*), the size of the infra-caudal lobe is so nearly that of the filament as to give the whole tail a nearly symmetrical outline, and lead zoölogists to speak of the "upper lobe," whereas it is really the bent-up end of the body. This kind of tail is called *heterocercal*.

The gars above mentioned are supposed to be the young of the *Lepidosteus osseus*. Just at what size the filament wholly disappears in that species is not known. But with the smaller and proportionally shorter species, *L. platystomus*, there is no sign of the filament when eighteen inches in length. The tail might then be thought, at first sight, to be symmetrical. But the longest rays are a little above the

middle, and dissection shows that the spinal axis is continued backward and upward as a cartilaginous rod,[1] terminating at the upper border, just under the hinder pair of *fulcra*, and at the point where the filament was attached. The rays are all attached to the lower border of the spine; and there is only a lower lobe of the tail.

A similar structure exists in the tail of *Amia*, which Prof. Huxley gives as an example of *heterocercal* tail. It seems better, however, to discriminate between it and the previous stage, where the upper lobe (filament) exists, and it may, therefore, provisionally be called the *masked heterocercal*, or perhaps the pseudo-homocercal.

Prof. Huxley has more recently given figures and descriptions of the tail of embryo Teleosts (*Gasterosteus*), in which the structure is nearly identical with that of the adult *Amia* and *Lepidosteus*.[2]



A. Protocercal. First stage of *Lepidosteus*. Permanent in *Amphioxus*, *Petromyzon*, *Lepidosiren*, *Polypterus*. Also in some ancient Ganoids, as *Glyptolæmus*.

B and *C*. Heterocercal. In the sturgeons, and most sharks, and many mesozoic fossils.

D. Not represented, so far as I know, among recent or fossil forms.

E. Masked heterocercal. In adult *Amia* and *Lepidosteus*. In the embryo of many Teleosts. In *Megalurus* and some other fossils of Mesozoic and more recent epochs.

FIG. 10.—DIAGRAMS INTENDED TO ILLUSTRATE THE CORRESPONDENCE OF THE SUCCESSIVE STAGES OF TRANSFORMATION OF THE TAIL OF *Lepidosteus*, WITH THE TAILS OF CERTAIN LIVING FORMS MORE AND LESS GENERALIZED, AND OF CERTAIN FOSSILS MORE AND LESS ANCIENT.

A, the first or *protocercal* stage, where the end of the vertebral column (*Ve*) is horizontal and divides the tail into upper and lower lobes nearly equal in size. *B* and *C*, the heterocercal stage, where the original tail is more or less elevated by the lower or infra-caudal lobe (*IC*), and becomes the filament (*Fi*), usually called the "upper lobe." In *D* the infra-caudal lobe is longer than the filament, and in *E* the latter has wholly disappeared, and the tail assumes the last or "masked heterocercal" condition.

The same author concludes that in many adult Teleosts the posterior end of the spine is more or less strongly bent up, although the tail is outwardly nearly or quite symmetrical.

[1] This rod consists of the notochord, and a slender prolongation of the spinal cord, surrounded by a cartilaginous sheath.

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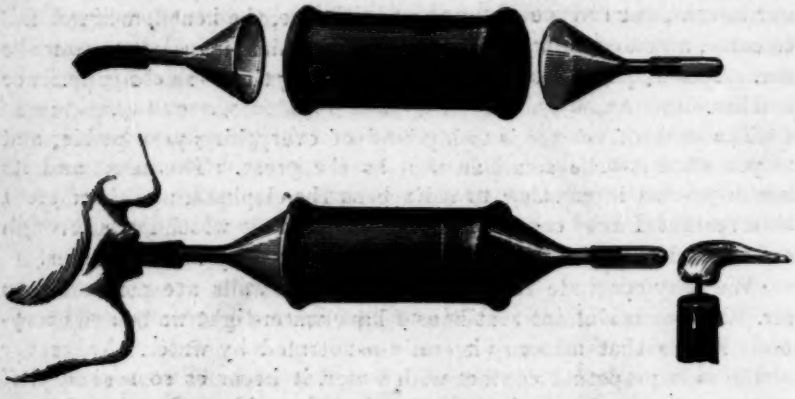
I have here a cylindrical piece of mortar, half lime, half sand, five inches by one and two-thirds. The cylinder has been covered all over with melted wax, which is inpermeable to air, with the exception of its two circular ends. You see this glass funnel, with a tube. I fix it on one circular end, where the mortar lies free, and make an air-tight connection by wax with the waxen coat of the cylinder. If I blow through the tube, the air must appear on the free mortar-end, pro-

vided the mortar is permeable to air. It has as yet no effect on the flame of this candle, because its velocity is not great enough. But if I fix a funnel on the other end of the cylinder, the air which has passed through the mortar can only escape through its narrow end, and there you see the flame sensibly deviating. You may even succeed in extinguishing it altogether. The velocity of the air in going through the tube must increase in proportion as the transverse section of the



tube is smaller than the mortar-surface, out of which the air escapes, exactly as with the water of the pond and its in- and outflow. Now, when I dip the end of one tube into water, you see and hear the air which has passed through the mortar escape from the water. If you make a similar arrangement with a piece of wood, or a brick, you will see the same result.

Most kinds, also, of sandstone are so porous that water and air easily pass through them. Solid or quarried limestones are scarcely permeable to air, but, as they are mostly of irregular shapes, they require more mortar, and that is the reason why such walls are, after all, not so much more air-tight than walls made of regular bricks and thin layers of mortar. Observations have been taken of the average quantity of mortar used with different building-stones. We may suppose that, taking the wall as a whole, it is one-third with quarried lime, one-fourth with tufaceous lime, one-fifth to one-sixth with bricks, one-sixth to one-eighth with cubes of sandstone. In practice, then, the quantity of the mortar rises with the decrease of porosity in the building-stones, and assists in keeping the walls pervious to air to a certain degree.

It is self-evident that the quantity of air which passes through building-materials of a certain thickness must increase in proportion to the surface; two square feet must give passage to twice as much air as one square foot. I shall speak of ventilation in connection with this later on.

The effect of wetting porous materials is quite surprising. In proportion as the pores fill with water, they become impervious to air. The adhesion of water to stone and mortar is greater than that of air, by as much as water is heavier than air. It is not difficult to blow great volumes of air through dry mortar and dry bricks, but it requires a great exertion to drive a few drops of water through the same materials. You know this cylinder of mortar (*see* above). Instead of blowing air through it into water, I will suck the air out of it: you see now the water rise in the tub and wet the surface of the mortar. Now I'll try to blow again air through the mortar; I cannot, with all my exertions, because the pores of the mortar are filled with water.

This simple experiment lays bare the great hygienic disadvantage of wet walls; they are air-tight, not to speak of other injurious effects.

We all know that new houses are dreaded on account of their humidity. In some countries there are regulations by law, and new houses must be approved with respect to their dryness before they may be let. But the notions about the causes of their humidity, and the means of removing it, are very different and discordant. Allow me, therefore, to explain how water gets into the new house, and how it is to be got out of it.

I need not call to your mind the first steps in a building operation, and how soon a connection is made with some abundant source of water, and that a great deal of water is required for making the mortar, etc. Let us now try to come to an estimate of this quantity of water.

Suppose that 100,000 bricks were used for a building, each weighing ten pounds. A good brick can suck up more than ten per cent. of its weight in water, but we will put down at five per cent. what gets into it by the manipulations of the bricklayer. We will assume that the same amount of water is contained in the mortar, a quantity certainly much understated, although the mortar forms only about one-fifth of the walls: we have thus 100,000 pounds of water, equal to 10,000 gallons, which must have left the walls of the house before it becomes habitable.

The two principal ways in which wet or damp walls are injurious are: 1. By impeding ventilation and diffusion of gases, through their pores being closed up or narrowed by water; 2. By disturbing the heat-economy of our bodies. Damp walls act as bodies abstracting heat in one direction; they absorb heat by their evaporation, and act like rooms which have not been warmed thoroughly; they are better conductors of heat than dry walls, just like wet garments, and considerably raise our heat-losses by a one-sided and increased radiation. Diseases which are known to be often caused by cold are particularly frequent in damp dwellings—rheumatism, catarrh, chronic Bright's disease, etc.

What can we do to get rid of that immense quantity, of these

10,000 gallons of water, before we remove into the new house? All this water—we cannot make it run off, we cannot squeeze it out, we cannot boil it away—it must take its leave in one way, a very safe but rather long one, that of spontaneous evaporation into and by the air.

The capacity of the air for receiving water depends on the different tension of the vapor at different temperatures, on the quantity of water already contained in the air flowing over a moist body, and finally on the velocity of that air. For the first two moments let us assume the average temperature of the year to be about 50° Fahr., and the average hygrometric condition of the air to be seventy-five per cent. of its full saturation. Under these conditions, one cubic foot of air can take up four grains of water, in the shape of vapor, but as it contains already seventy-five per cent. of these four grains, which amounts to three grains, it can only take up one additional grain. As often, then, as one grain is contained in the 10,000 gallons of water mentioned above, as many cubic feet of air must come in contact with the new walls, and become saturated with the water contained in them; or about 700,000,000 cubic feet of air are required to dry the building in question.

I will at once pass on to the consideration of a subject which some of you may be acquainted with already by experience—I mean the reappearance of damp in new buildings, which had seemed quite dry, after they had become inhabited. There appear damp spots on walls and in corners, the panes in the windows sweat, and the air becomes musty and oppressive. How does this water return, after the house has been declared and considered dry? Most people, because they see it only then, suppose that there is a new formation of water in the wall, or that it was set free by the presence of the new dwellers. Here, again, our sensuous perceptions mislead our judgment, and give us no clew as to the circumstances under which moisture in the walls becomes visible to our eyes and humidity produces a damp spot. 'I produce here a piece of brownish-yellow paper of somewhat indistinct tint. Where I wet it with water, the color appears more intense, darker even, just as if the water had been colored. Now the paper is getting dry again, and the former appearance comes back.

Some of you may laugh at me for making such a trivial experiment, but I beg to ask, What is the reason of this action of the water? It takes place only on porous colors or colored surfaces which are porous, only on *aquarelles* or frescoes, scarcely on porcelain or glass paintings. If the water cannot penetrate into the color it cannot alter its appearance any more than that of a colorless, transparent glass.

Oil-paintings, when they are new or lately varnished, are in this respect like glass-paintings, but when they get older, some of the colors, by the longer action of the air, get dull, and then water has the same effect on them as on this paper. It gives them a fresher appear-

ance till it has dried away. This is because all oil-colors become porous in the course of time.

For water to penetrate thus into the colors, we are entitled to assume that there must be free spaces within them to receive it, pores and interstices. These cannot have been *vacua* before, but must have contained air. This air in the painted surface is displaced by the water, and hence the difference in the optical effect. Air and water have different optical properties. In the first instance our colors—dry and dulled—are mixed with air; in the second instance with water. Water refracts, disperses, and reflects light quite differently from air; therefore it must have quite a different effect on colors when it gets admixed with them instead of air. The whole question has been more fully treated by me in a little treatise on oil-colors and the preservation of galleries; it may suffice here, and for the present, to know that damp spots on a wall can appear only when the pores are filled with water or some other transparent liquid. Our sensations have rightly taught us to associate the words dry and airy, damp and confined.

If we have moved into a new building too soon, we may be deceived by its appearance. It is quite possible that the walls have become sufficiently free from water and full of air for the colors of the papers and walls to appear mixed with air and free from all interstitial water; still, we are not entitled to suppose that all water has left the walls. A good deal may remain unnoticed, provided some air is lodged in the pores of the surface sufficient to produce the optical effect of real dryness.

How does it, then, happen that, on receiving their complement of inhabitants, the pores of the new walls become obstructed, partly or locally, by water? The ordinary explanation is completely erroneous, although it sounds quite scientific and rational, and has its place in books and lectures on chemistry. It is stated that it is the effect of carbonic acid on the hydrate of lime which remained in the mortar. Mortar is a very interesting object, and I regret that I cannot enter more fully into its nature and process of hardening. I'll tell you so much, that the burned and slaked lime used for its preparation is a compound of lime (oxidized calcium) and water, the above-mentioned hydrate of lime. This, by the action of the air, is changed into carbonate of lime. This change takes place at first very rapidly, and to the extent of about one-half, but then slower and slower, so that in very old masonry one finds frequently some of the original hydrate of lime. This is a perfectly dry substance, which yields none of its water to air which is dry and free from carbonic acid. When changed into carbonate of lime, the water, which as a hydrate it contained, chemically combined, is set free, while the lime and the carbonic acid combine. This water is commonly considered to produce the damp spots which appear here and there in new buildings. It has been im-

agined that the respiration of the new inmates increases the amount of carbonic acid in the air, and accelerates the process, setting free the water, which renders the wall damp and chokes up its pores.

This explanation is not based on any single direct observation made on the wall itself; it is nothing but a specious conclusion. Although hydrate of lime exposed to air which contains carbonic acid changes into carbonate of lime, no one has ever found it becoming moist. The liberation of the water, however much it may be accelerated in the indicated way, is unable to refill the pores of the wall, which were supposed to be already filled with air. To do this it would be necessary that the water in the hydrate should not have occupied any space, or that, when set free, it underwent such an expansion as water becoming a gaseous substance. All scientific analogies and observations protest against this. Changes of solid into liquid bodies take place without any considerable increase of volume; it is different with the transition of liquids into gases when the increase is very considerable.

It is only by the complete choking up of the pores by water, and the complete expulsion of the air from the surface of the wall, that the damp spots can be formed; and the freed water of the hydrate, which cannot fill a space which it had not filled while in its former combination, cannot do this. So the absorption of the carbonic acid is unable to produce the required increase of volume.

The fresh spots in new buildings can only arise from the precipitation of water from the air on the walls.

The inhabitants of a house give rise to a great amount of watery vapor, not only by the functions of their lungs and skin, but also by the numerous manipulations of the household, such as cooking, washing, cleaning, etc. If the air in the house is already saturated with water in proportion to its temperature, a small degree of cold in the wall is sufficient to produce a dew, a precipitation of water from the vapor, just as one sees it on window-panes. But the porous wall can imbibe a good deal, and in old buildings we may see the windows sweating profusely while the walls seem to remain dry. It may last a long time before a well-constructed wall or partition gives any sign. They go on condensing water till their pores are filled and all the air expelled—then, not slowly and gradually, but all at once, numerous damp spots make their appearance.

It is, therefore, clear why those youngsters of houses are so much more subject to damp spots than their brethren of more mature age. Their walls have lost just enough of the building-water to allow the air to occupy part of the pores; optically, they seem dry, but still very little water is required to choke up the pores here and there anew, and wherever this takes place the spots break out. The effect of a fire is very instructive; nothing produces damp spots so easily in a fresh building as the first fire, when doors and windows are well

closed. The heat from the fire begins by heating the places nearest to it, and a good deal of water evaporates, so that the air in the room must come nearer its point of saturation. But at a distance from the fire, the walls being colder than the air, dew falls, and, if the pores still contain great quantities of the building-water, they soon begin to overflow.

Another proof that the water chemically combined with the hydrate of lime is not able to fill the pores when it becomes liquid lies in its proportionately small quantity. A house built, let us say, with 100,000 bricks, contains, at most, about 33,000 pounds of burned lime. This cannot combine with more than about 10,000 pounds of water in becoming a hydrate. By the time the mortar is hard and set, and the building becomes inhabited, probably one-half of the lime has become a carbonate, and there remain only 5,000 pounds of water in the remaining hydrate, which is five per cent. of the whole mass of 100,000 pounds of water which got into the new building during its erection. If, then, the other ninety-five per cent. of the building-water were gone, the five per cent., or even ten per cent., remaining, or formed by the change of hydrate into carbonate of lime, would not produce the optical phenomenon of dampness.

I have dwelt somewhat longer on this subject because it is indispensable for a correct view of the function of the wall: the removal into the open air of a great part of that watery vapor which develops itself in every human household. Our walls have to swallow a good deal of that vapor as water, and to pass it on through their body that it may evaporate on their outer surface. That is the reason why localities looking to the north, or shaded from the sun, are so much damper. This appears most clearly in unheated places, chiefly at the transition from winter to spring, when it is warmer outside than inside. We are glad to have once more the windows open to let the tepid spring air gladden the cold interior; but a good deal of water will soon be seen deposited on the walls and the objects within the rooms, which has to evaporate just as from a new building.

You are now well aware of the usefulness of porous building-materials; they alone can make dry dwellings. I cannot help thinking badly of all the substitutes for wood, brick, and mortar, which have been proposed, as zinc, iron, putty, etc. Perhaps the natural functions of the mortar-wall may one day be efficiently exercised by something else; for the present it has not been done, and will not be done as easily as many so-called practical people suppose.

Let me just relate to you a case, which shows that, without a correct view of the functions of walls, an apparently excellent plan may just produce the reverse of what was intended. In the neighborhood of iron-smelting works, the slag is often used for building-purposes. This material, associated with other stones, does very well. As it exists only in very irregular shapes, it requires large masses of mortar,

and in our case this was believed to be undesirable. So it was decided to take only large regular pieces for the erection of a large workmen's dwelling, by which means the application of mortar could be reduced very much. It was a pleasure to see how quickly the building proceeded, and how much more quickly it got dry and habitable than other buildings, where irregular pieces and much mortar had been used. As soon as the workmen and their families began to live in the new building, the traces of damp began to show, and at last the house became the dampest in the whole establishment, and remained so. The thin layers or bands of mortar could not dispose well of the water which was deposited from the air in the house, and this was the worse, as the slag is not like brick and mortar, which suck the water up, but is a vitrified substance, on which water precipitates as on a window-pane.

But how are we to judge, in a given case, whether a house is sufficiently dry? No doubt, in every locality a practical experience establishes itself, founded on the knowledge of the usual material, the manner of building, and the climate. But if, as in some countries, some authority has to declare a house dry and habitable before it is to be let, there will be no end of disputes between this authority and the proprietor, because, after all, apart from the age of the building, the verdict of the experts will be given on their subjective view, not on definite and palpable signs. You know, already, that the absence of damp spots means very little. Feeling by the hand the temperature of the walls, knocking at them with a little hammer, are all of not much good. Not a bad plan is to get from different places in the house small pieces of mortar, and to have them examined as to their contents of evaporable water, which ought not to be more than five per cent. of the weight. But we may have fallen just on dry places only, and get considerably deceived. Direct and comparative hygrometric observations would be best, but the necessary preliminary researches for this kind of examination are still to be made.

But what is to be done if a new building is to be brought quickly and surely into a condition of dryness? I have been obliged to shake your belief in the one means which appeared to exist, the development of carbonic acid by burning charcoal in basins or open stoves. But I shall try to give you something in exchange for what I have taken from you. This something is nothing but an appeal to what we have learned above. There are no means of removing the water from a fresh building but by letting it evaporate into the air. This evaporation, you know, depends on the temperature, the humidity of the air, and its velocity.

Imagine to yourselves a moderately-sized room of 3,530 cubic feet, and the temperature and humidity of the air at the above given mean averages. As one cubic foot of such air is capable of taking up one additional grain of water, the air of the whole room will take up 3,530

grains, or about half a pound, of water. Should there be no change of the air, matters would remain so. But by every fresh 3,530 feet of air coming into the room another half-pound of water would be taken up, and so on. Suppose the change amounts to 353 cubic feet per hour: all the moisture we get rid of per hour would be only 353 grains per hour. But if we heat the room to 68° Fahr., for instance, we increase the tension of the vapor, i. e., the capacity of the air for taking up water, from four to seven grains per cubic foot, so that each cubic foot of fresh air entering the room is capable of taking up seven instead of four that means four grains in addition to its original humidity; In consequence of this increased capacity, the 353 cubic feet of air take up 1,412 instead of 353 grains of water. But by the increased difference of temperature between the room and the open air, ventilation rises from 353 to 2,100 cubic feet per hour, and in this way we get rid of more than twenty times as much water as if we left the room unheated.

All kinds of stoves and charcoal-dishes act only as sources of heat, and not as sources of carbonic acid. The only rational and efficient way is the *heating of all the chimneys and stoves, and the continual ventilation of all the rooms.* All other ways are of no use, or deceptive.

You have seen that the wall has its physiology, a life of its own. Perhaps you will no longer find it so strange that Master Quince introduces not only a pale moonshine and a rough lion, but also a "sweet and lovely wall" as a living and talking person. I had many things more to tell you about the wall, but I have still another subject of special importance before me—the change of the air in the house, or ventilation.

We have seen already, in speaking of our clothes, that the well-being of our body requires a continuous current of air to flow round us, and for the same reason a flow of air must take place continually from the open air through our dwellings. It used to be a current belief that in the still air of our houses we were separated and shut off from the external air. You know that this error arises from our nerves and senses believing the air to be quite calm and motionless, although there may be some movement. We must be thankful to our Creator for this our error, else we should probably have ceased to exist. However anxious we may have been to shut ourselves up from the external air, we still remain in connection and intercourse with it. No house can have an atmosphere of its own; it has that by which it is surrounded, which travels and flows through it slower or quicker, while the house, and whatever exists and goes on in it, have no other power than to render this air more or less impure.

This pollution must not overstep a certain line, and this line depends on the proportion between the pollution and the change and volume of the air-current.

We change and pollute the air within our houses in two ways: 1. By admixture of substances which were not in the air when it came to us; and, 2. By changing its normal composition. Both are unavoidable, but there are limits, which must not be overstepped. The impurities may be in the nature of gases, or dust. We often become aware of them by our senses, by sight, by taste, mostly by smell. The last sense is exceedingly sensitive for many substances; for instance, traces of ethereal oils. Nothing is more wonderful than its acuteness with some savages and animals. If we consider the minuteness of the substances left by hunted game on the soil, which it scarcely touches in its flight, and how the dog detects them even a long time after, we cannot sufficiently admire such a performance of the sense of smell. Other substances make themselves known in other ways, sometimes by some physiological effect. Oxide of carbon, for instance—a gas which is generated from burning charcoal—is not perceived by any of our senses, but if it is present in air to the extent of a half per cent. only, it destroys human life after a while. A few grains of veratria, rubbed down into a powder, will set all the persons in the room sneezing. Other substances, as the products of distillation of fats, or the smoke of wood, irritate the membranes of the eyes. Other vapors and kinds of dust act on the taste; for instance, aloe-powder.

We rightly consider all air, which acts on our senses or our feelings differently from air in the open, to be polluted.

The second way in which we render the air impure on its journey through our houses is that of altering the quantities of its components. We deprive it of oxygen by our respiration, by the burning of lights and fires; we increase its carbonic acid and its water by the activity of our lungs and skin, and by numerous proceedings of the household.

All these pollutions and alterations are partly avoidable, partly unavoidable. Among the latter are those by our lungs and skin, because we cannot live without producing them. To the former belongs everything that from want of cleanliness, careless treatment of waste and refuse, passes into the air-current, the utilization of which ought to be the privilege of our skin and lungs. It is an inexcusable waste of ventilation, if it is directed against avoidable pollutions of the air, besides its being generally of not much use for this purpose. If I had a nuisance in my room, I should be a fool if I kept it there and trusted to stronger ventilation. The rational way is to do away with the pollutions, not to keep them and to fight them by ventilation. Without strict cleanliness in a house or public institution, all contrivances for ventilation will not do much good; the proper domain of ventilation begins where cleanliness, by rapid removal or careful shutting up of air-polluting substances, has done its best. It is only against the deterioration of the air by respiration and perspiration, which is beyond

the control of cleanliness, that ventilation can direct its power, and against this deterioration this power must be chiefly directed.

Let us now consider the different causes of the motion of the air. As air in motion is wind (*ventus*, Latin), ventilation is a better expression than "airing." Anything which disturbs the equilibrium of a body of air, produces motion in it. Its immobility supposes equality of temperature and specific gravity, and also of mixture in quantity and quality. Such conditions, as you may suppose, are seldom present, and absolute calmness is impossible. Different kinds of gases tend to intermix in every direction, even contrary to their specific weight, a process which is called diffusion; but this kind of motion is not in question when we speak of ventilation. Ventilation means the setting in motion of masses of air by mechanical pressure and the dislodging of whole bodies of air similarly composed, which, for that reason, are not subject to diffusion.

We produce ventilation by disturbing the equilibrium of the air in two ways: 1. By producing differences of temperature between two neighboring bodies of air, which are accessible to each other; 2. By mechanical pressure on or driving off the air in a certain direction. We cause the same motion in either way, but the first we call *draught*, the second *wind;* we call forth a draught by a chimney, we produce a wind by a fan, a fan-wheel, etc.

These two factors of change of the air are continually active in our houses, but to a very different extent at different times. Our houses stand in the open air, which is never quite calm; even if it appears so, there is still some imperceptible motion, some wind disposable for ventilation. Then our houses are either colder or warmer than the surrounding air. They act just like large chimneys. If they are colder, the air which comes in contact with them gets colder, and a downward air-current is produced; if they are warmer, the air gets warmer, and an ascending current is established.

It is evident that the intensity of the change must also depend on the way in which the house is shut up, on the size and number of its apertures, and the porosity of the materials it is built with.

For this reason a certain amount of ventilation is always taking place wthout any special arrangement for it, but its strength depends —1. On the amount of difference of temperature between outside and inside; 2. On the strength of the wind or air-motion in the open; 3. On the size of the apertures which are open to the change of the air. We may call the first two the air-motors, the last the air-mediator or janitor, door-keeper; to a certain degree, they can take each other's place. If there is not enough difference of temperature, as, for instance, in summer, the wind can act; if both together are too weak, opened doors and windows can help. In winter, when the difference of temperature between the in- and out-door air is considerable, small openings allow the passage of as much air as large open-

ings during summer, because the difference of pressure is greater. When, in winter, we stay in an unheated room, whose temperature is only slightly above that of the outer air, ventilation is quite as weak as in summer; the air, if the windows remain closed, becomes quite as bad by our presence, and we ought to air the room as in summer; but we do not, because we want to protect ourselves against the outside cold. The dwellings of the lower classes present frequently, during the greater part of winter, this form of defective ventilation, which gets worse with the length of the cold season. In the beginning the walls are still dry and porous, and assist the ventilation, so far as the wind helps them to do so; but in proportion as they get colder, they increasingly condense water from the air of the house, and finally become so choked up with it that they allow no air to pass, as you have seen in our moistened piece of mortar. Bad doors and windows, unmended window-panes, remain often the only routes of ventilation. Poor people, in complaining of them, are not aware that they are the smaller of many evils, and a defect without which they might suffer still more.

Many of you, on hearing this, may be gratified by an unexpected personal satisfaction. Those who try to alleviate the poor man's winter by gifts of fuel not only procure for him the benefit of a warm room, but also of a better and purer air in this room. You may consider this as a scientific parable, showing that in each benevolent action there lies a further blessing, even if we had not intended it.

It follows, from these fundamental principles of ventilation, that a great mistake is sometimes made in large dormitories. In the morning the custom is to open the windows, and to let them remain open all day long, to be closed only just before bedtime. The poor sleepers fancy that they are sleeping all night in a pure air. Whoever has occasion to enter such a place in the morning, before rising-hour, starts back before this "pure air," which had only been renewed during the night partially and accidentally, and is so loaded with all kinds of animal emanations that it presses with all its power on the fresh comer. If there is no sufficient difference of temperature between outside and inside, a partial opening of the windows during a winter night is just as necessary as during a summer night, as far as regards the change of the air.

The bodies of the sleepers are certainly a small source of heat, and such large sleeping-places become somewhat warmed by the human heat flowing from the beds, but they can never be warmed through and through, so that the walls could become warmer. The water-vapor exhaled by the sleepers condenses against the walls, and goes on obstructing their pores till morning. A part of this water may evaporate during the time that the windows are kept open, but it will be only a part, and hence the frequent breaking out of damp spots in such dormitories in the course of the winter.

There was a belief that sleeping in the cold was a good thing; but I cannot find any facts proving this theory, particularly no comparative observations about the wholesomeness of heated and unheated dormitories. It would be safer to say that experience proves that sleeping in the cold does not, generally, do harm. If a single person sleeps in a large cold room with shut doors and windows, it will do him no harm when he has a good bed. One person cannot deteriorate the air of an unventilated space as much as two or more. The bed is a garment, an apparatus, which is of great use for our heat-economy; it prevents our feeling cold even in the coldest dormitory, but the bed is no ventilating apparatus, and ventilation must be provided for in another way. He that wants to sleep safely in the cold must have a good bed and a large space, or bad windows and doors, or very porous walls, or he must keep his windows partly open in winter as well as in summer.

You have probably now the desire to hear from me how much air or ventilation a person wants in a stated time. After you have all the while heard from me that everything is full of air, that air penetrates everywhere, and that it is extremely difficult to prevent its passage, many among you will ask: "What need is there of special contrivances, if the air passes through each brick, through mortar, through wood? Would it not be rather desirable to protect ourselves against this universal aggression of the air?"

It is with air as with all things which we must have—as with money, of which we must not only have some, but sufficient—one must have as much as one requires. Some money is, after all, in everybody's possession, even that of the poorest beggar.

Till some time ago, ventilation was chiefly considered in its qualitative aspect: we wanted change of the air, and were satisfied if there was one aperture for it to go out, and another to come in. The question about the quantity of this air was never put; if it had been known how much was really wanted, and how it was to be procured, that amount of ventilation which was often paraded would have appeared beggarly. It is only during the last twenty years that we have acquired clear ideas on this subject.

We deteriorate the air of a closed space inevitably by using it for the maintenance of our respiration and perspiration. To which degree, then, may we alter or pollute by our emanations the air of a closed space, without going so far as to injure our health? This leads us to another preliminary question: What standard have we for measuring the deterioration of the air?

At all times people have been in the habit of making some estimate of the pollution of the air by the smell imparted to it by the respiration and emanations of the persons staying in it. This estimate is of the same value as that we have spoken of when on the subject of the water in the walls. The smell of a certain air need not be in any kind

of proportion to the use which has been made of it already for the purposes of respiration and evaporation. Besides, smelling is a very subjective sensation, of very different excitability in different persons. Although generally a certain rule for judging the air of a room may be based on its smell, the decision, in doubtful cases, will always be a subjective one. It would be a different thing if we could lay hold of the smelling particles in the air of the room, and measure or weigh them, and compare them with the volume of air they were taken from; but we have no method of doing this; everything is left to our noses.

For this reason I considered it indispensable to look about for some means which would make us independent of our subjective estimate. I started from the excretion of carbonic acid, as it takes place from the living human body; its quantity in the air can be ascertained easily and accurately. There is some in the open air, although very little; the question was, therefore, to find out its increase in a number of inhabited rooms, with notoriously good and notoriously bad air, and to draw a comparison. The correctness of this proceeding depends on the supposition that there are no other sources of carbonic acid but the inmates, that there are no burning flames, or tobacco-smoking, etc. I will not say that I consider the detected carbonic acid as the principal drawback to such air; it is, in my mind, the measure only for all the other alterations which take place in the air simultaneously and proportionately, in consequence of respiration and perspiration; its increase shows to what degree the existing air has been already in the lungs of the persons present. All other functions in which the air participates keep in some proportion to the respiration.

A series of examinations have resulted in the conviction that one volume of carbonic acid in 1,000 volumes of room-air indicates the limits which divide good from bad air. This is now generally adopted and practically proved, always provided that man is the only source of carbonic acid in the space in question.

Suppose there is a known source of carbonic acid: the determining the amount of it in a room can also be used for measuring another element, which would otherwise defy calculation—I mean the amount of ventilation of a closed space of definite construction. Imagine to yourselves a room with its walls, windows, and doors, its numberless penetrable places through which the air holds ingress and egress. It is impossible to measure the velocity of the air at each crack, to measure each little hole, the diameter of each pore, even if one had the means of measuring such minute velocities and sections; yet still we should like to know how much air changes in a given space, and under different external circumstances. The only way appeared to me to be to mix the air of the room in question with carbonic acid to a certain degree, then to break off this mixing, and to observe the decrease of the acid in proportion to the air in definite times. Knowing the

amount of the acid in the external atmosphere, we can calculate how much of the latter must go on mixing itself with the room-air, to which carbonic acid has been added, in order that the proportion of the acid may decrease by so and so much in a definite time. The action of diffusion or absorption may generally be left out of consideration in this calculation. I do not consider this method to be absolutely correct, but I have found it quite satisfactory when a building was a few years old, and quite dry. At all events, until a better method has been found, we must keep to this one, even if it were still less complete than it is.

By researches which are too complicated to be explained in a popular lecture, it has been found that the ventilation of the same room or space, when the doors and windows are shut, undergoes considerable and definite alterations under different circumstances. Ventilation has been found to be much greater than had been supposed before. On an average, in spaces in which the air kept good, there existed a ventilation of more than 2,100 cubic feet per head and hour. It is known that a person does not inhale and exhale more than eighteen cubic feet of air per hour, and so it was thought that 2,100 cubic feet per hour was a ridiculously large quantity for one person.

But it has been shown, first in France, not by calculation, but quite empirically by simple experimenting, that this quantity of ventilation is not more than is absolutely indispensable. After the epidemic of cholera of 1848, the erection of a model hospital in the Faubourg Poissonnière was decided upon, and the Hôpital la Riboisière was erected, which was to be furnished with artificial ventilation. The quantity of air which was required from the ventilating apparatus was stated in the plan. It was believed that the demands put under Nos. 4, 5, and 7, of the plan for ventilation, were extraordinarily large:

4. Continuous ventilation of warm-air in winter and cold air in summer at least 700 cubic feet per hour and bed in the large wards.

5. Ventilation during the day only at 350 cubic feet per bed in the rooms of the corresponding pavilion.

7. The ventilating apparatus must have a surplus of strength, in order to be able to produce in all or some wards a ventilation double that stated.

The air was partly propelled by fan-wheels, partly by ventilating-flues. It flowed to and fro through pipes in the wards, and its velocity could be measured easily by anemometers.

In preliminary experiments, a ventilation of 350 cubic feet per bed and hour was tried, but the air was found already by the smell to be so bad that the authorities congratulated themselves in having provided for double the strength. This was now tried, but with the same result, and it was a comfort to know that, for extraordinary cases, another 700 cubic feet per bed and hour could be obtained; but

then also the state of the air was anything but desirable. It was only with 2,120 cubic feet that the medical and other authorities found themselves satisfied.

At present the demands for ventilation in France sound very different from what they were about twenty years ago. They are now per hour and person:

Hospitals for ordinary cases	2,120—2,470 cubic feet.
" wounded	3,530 "
" epidemics	5,300 "
Prisons	1,766 "
Workshops, ordinary	2,120 "
" unhealthy	3,530 "
Barracks, day	1,060 "
" night	1,410—1,765 "
Theatres	" " "
Large rooms for long meetings	2,120 "
" " shorter "	1,060 "
Schools for children	424— 530 "
" adults	880—1,060 "

Such are the changes of times.

Now the many crevices, holes, and pores in our dwellings will no longer be considered by you as unlimited means of change of the air, since you know how large that change has to be; you will rather feel anxious whence to procure such enormous quantities when you sit quietly within your four walls where you do not feel the least draught, where no curtain moves, and a feather lies quietly on the floor. This sensation of calm we owe to the insensibility of our nerves—*and yet the air moves.*

In order to give you some idea of the influences of differences of temperature of more or less well-shutting doors and windows, of a fire in a stove opening into the room, and of the partial opening of a window, I will give you shortly the results I obtained with the aid of the carbonic-acid measurement. The room had brick walls, and its size was 2,650 cubic feet.

With a difference of temperature of 34° Fahr. (66° in- and 32° outside), the contents of the room changed once in one hour, equal to 2,650 cubic feet.

With the same difference, but a good fire in the stove, whose communication with the chimney was made as free as possible, the change of the air rose to 3,320 cubic feet, or about twenty-five per cent. When all openings, crevices in windows and doors, were thoroughly pasted up, there was still a change of 1,060 cubic feet per hour, or a fall of twenty-eight per cent. With a difference of temperature of 71° in- and 64° outside, the change amounted to 780 cubic feet only per hour. When opening a window of eight square feet, the change rose to 1,060 cubic feet per hour. These quantities are instructive. They show that a difference of temperature of 34° with carefully-shut openings

and crevices is of greater influence than large communications with the outer air at a small difference of temperature.

The roaring fire and the draught of the stove produced only an increase of 700 cubic feet—one-third only of the necessary ventilation per head. I have examined a number of stoves opening into the room for the quantity of air which they abstract while the fire burns. The anemometer showed that it was never more than 3,105 cubic feet. Large wards in hospitals, schools, etc., heated by one open fireplace or stove, are sometimes wrongly believed to be well ventilated, because one perceives the air rushing into the same. But the main point is to know the quantity of required air and the quantity of outgoing air.

The free wall of a room of mine has been examined for its ventilating power. The room contained 2,650 cubic feet, and at 9.5° Fahr. difference of temperature between outside and inside, the spontaneous ventilation through each square yard amounted to about seven cubic feet, or forty-three gallons per hour.

Märker and Schultze, in their researches on the spontaneous ventilation of stables, have found for one square yard of a free wall, at 9.5° Fahr. difference of temperature, that the spontaneous ventilation amounted per hour—

With walls of	sandstone	to	4.7	cubic	feet.
" "	quarried limestone	"	6.5	"	"
" "	brick	"	7.9	"	"
" "	tufaceous limestone	"	10.1	"	"
" "	mud	"	14.4	"	"

Domestic animals, according to Märker, require a proportionately smaller change of the air than man. Stable-air may contain up to three per mil. carbonic acid. While man's ventilation requires 2,100 cubic feet per hour, 1,050 are sufficient for full-grown cattle, although their bodies and consumption of air are so much larger. The ventilation of stables depends chiefly on the size and porosity of their free walls. It has been found that the 1,050 cubic feet mentioned above were furnished by—

21.16	square feet of a free wall of				sandstone.
15.33	"	"	"	"	quarried limestone.
12.6	"	"	"	"	brick.
9.7	"	"	"	"	tufaceous limestone.
7	"	"	"	"	mud.

A stable built up of mud can therefore shelter many more animals than one built of sandstone, etc. "As the strength of the natural ventilation of a stable does not depend on the cubic space of the stable, but on the extent of its ventilating walls, it follows that in a small stable a proportionately greater ventilation takes place than in a greater one, because for each animal there is more ventilating surface with equal cubic space."

This proposition naturally applies also to human habitations. The air will be better in a small family house than in large barracks; better in a cellular than in a common prison, where the day and night wards are large but crowded.

The question arises, "What is to be done in all cases in which the natural ventilation of the inhabited spaces proves insufficient, and allows the carbonic acid to become more than one per 1,000?" I might tell you now of the different systems of ventilation, the contrivances and apparatus belonging to them; but this is not feasible without models and designs. And, after all, there would be no new principles or natural laws to acquaint you with. I believe I have made you sufficiently aware of the fundamental facts and conditions as to the change of the air in our dwellings, so far even that you are now able to judge for yourselves whether a certain plan for ventilation is rational or not. We have no other motors for changing the air, but differences of temperature and motion of the air, which we can call forth either by heat or by the motion of wind-fans—or which we must make use of as far as they are preëxisting in the atmosphere surrounding the house. By these two means we can produce certain perturbations in the equilibrium of the air-columns, and through this certain degrees of velocity in the motion of the air.

If we know the transverse section of the inlets and outlets, we have only to multiply their surface by the velocity of the air, and this will give the cubic quantity of the air which flows through the channels in a certain time. If we know the required quantity of air and divide it by the transverse section of the channels, we get at the velocity of the air in the channels. We ought not to establish a greater velocity than nine feet per second; it is better to enlarge the channels. These quantities must then be compared with the air required by each person, a quantity with which you are now acquainted.

If you take up the question of artificial ventilation in its quantitative aspect, you protect yourself at once against a series of errors into which else you easily fall. Our ordinary dwelling-houses need not be ventilated artificially; we ought never so to crowd them that the natural means of ventilation, as difference of temperature, motion of the air in the open, dry and porous walls, and temporary assistance by the architectural openings, are insufficient to keep undeteriorated what is most essential for our health. With these means there must go hand-in-hand the greatest cleanliness in all parts of the house, and abstention from all superfluous and avoidable pollution of the air of the house.

Before concluding, I am desirous of considering with you an expression which is in general use, but the frequent cause of wrong views about the change of the air. I mean the word *draught*. All kinds of complaints are habitually ascribed to it, and the danger of

draughts is one of the few hygienic principles which have become thoroughly popular. Perhaps this was not all profit, because with many people ventilation and draught are synonymous; they are afraid of a draught coming from an open window, an open door, and find themselves in collision with ventilation.

There is certainly and frequently danger in being exposed to a draught—a danger which has, perhaps, been over-estimated, because men have an irresistible desire to fix a certain cause for a certain evil. All collision is avoided if the proper meanings of *ventilation* and *draught* are thoroughly understood.

Ventilation is the necessary change of the air in a closed space, at which the velocity of the air is still taken for a complete stillness, and its motion takes place all round our body. It must not be more than a little above nineteen inches per second.

Draught is a one-sided cooling of the body, or some part of it, frequently caused by a corresponding motion of cold air, but also in other ways, as by increased one-sided radiation. The danger is, in the first instance, the local perturbation in our heat-economy, which has partly local consequences, but also and chiefly disorders the nerves, acting on the calibre of our blood-vessels, our vaso-motor nerves, which have to regulate the outflow of our heat. When we are in the open, and the air is in more motion than the air of a draught, we speak of wind, etc., but seldom of draught, because the whole air-current flows equally all round us, just as in a well-ventilated room, only with greater velocity.

The vaso-motor nerves, regulating the circulation in our skin, are beyond our control, and we cannot bid them to defend us simply at the place attacked by the draught. They know only how to serve our heat-economy when the outflow of heat from our bodies is equal, or nearly so, on all sides. They misunderstand the local irritation for one spread over the whole surface, and act at once on this error. If one perspires and goes to the window with bared neck or chest, one feels a shiver not only there but all over the body, and the perspiration becomes suppressed accordingly. The blood which at the time filled the blood-vessels of the glowing skin is displaced by the contraction of its channels; but by the misunderstanding of the vaso-motor nerves it is driven not only from the exposed parts but from the whole surface toward the internal parts. If one or some of them are in some state of weakness, danger or bad consequences cannot fail. It is the same thing as with a large quantity of cold water taken in too quickly when the body is heated. A draught, then, is injurious only in so far as it causes perturbations in our heat-economy, and as these perturbations can be caused in different ways we often accuse the draught wrongly.

We hear often, "I don't like sitting near this window, close to this wall," and so on; "there is always a slight draught coming from

there." We fancy that we feel the draught, the motion of a wind, but it is mostly increase of one-sided heat-loss by radiation toward the cold place. People generally believe, rather, that the wind comes through the wall. But the velocity of such a wind is too small to be felt as air in *motion*, and a piece of carpet fixed to the suspected wall does away with the supposed draught. It could, therefore, not be caused by the air-rush through the wall, because the carpet is many times more permeable to air than the wall.

I hope, in future, ventilation and draught will be to your mind two distinct things.

SPINOZA: 1677 AND 1877.[1]

By ERNEST RENAN.

ON this day two hundred years, in the afternoon, and at about this same hour, there lay dying, at the age of forty-three, on the quiet quay of the Pavilioengragt a few paces hence, a poor man, whose life had been so profoundly silent that his last sigh was scarcely heard. He had occupied a retired room in the house of a worthy pair, who, without understanding him, felt for him an instinctive veneration. On the morning of his last day he had gone down as usual to join his hosts; there had been religious services that morning; the gentle philosopher conversed with the good folk about what the minister had said, much approved it, and advised them to conform themselves thereto. The host and hostess (let us name them; their honest sincerity entitles them to a place in this beautiful Idyl of the Hague related by Colerus), the Van der Spycks, husband and wife, went back to their devotions. On their return home, their peaceful lodger was dead. The funeral, on the 25th of February, was conducted like that of a Christian believer, in the new church on the Spuy. All the inhabitants of the district greatly regretted the disappearance of the sage who had lived among them as one of themselves. His hosts preserved his memory like a religion, and none who had approached him ever spoke of him without calling him, according to custom, "the blessed Spinoza."

About the same time, however, any one able to track the current of opinion setting in among the professedly enlightened circles of the Pharisaism of that day, would have seen, in singular contrast, the much-loved philosopher of the simple and single-hearted become the bugbear of the narrow orthodoxy which pretended to a monopoly of the truth. A wretch, a pestilence, an imp of hell, the most wicked atheist that ever lived, a man steeped in crime—this was what the

[1] Address delivered at the unveiling of the monument at the Hague, February 21, 1877.

solitary of the Pavilioengragt grew to be in the opinion of right-thinking theologians and philosophers!

Portraits were spread abroad exhibiting him as "bearing on his face the signs of reprobation." A distinguished philosopher, bold as he, but less consistent and less completely sincere, called him "a wretch." But Justice was to have her day. The human mind, attaining, in Germany especially, toward the end of the eighteenth century, to a more enlightened theology and a wider philosophy, recognized in Spinoza the precursor of a new gospel. Jacobi took the public into his confidence as to a conversation he had held with Lessing. He had gone to Lessing in hopes of enlisting his aid against Spinoza. What was his astonishment on finding in Lessing an avowed Spinozist! "Ἓν καὶ πᾶν," said Lessing to him—this is the whole of philosophy. Him whom a whole century had declared an atheist, Novalis pronounced a "God-intoxicated man." His forgotten works were published, and eagerly sought after. Schleiermacher, Goethe, Hegel, Schelling, all with one voice proclaim Spinoza the father of modern thought. Perhaps there may have been some exaggeration in this first outburst of tardy reparation; but time, which sets everything in its place, has substantially ratified Lessing's judgment; and in the present day there is no enlightened mind that does not acknowledge Spinoza as the man who possessed the highest God-consciousness of his day. It is this conviction that has made you decree that his pure and lowly tomb should have its anniversary. It is the common assertion of a free faith in the Infinite that on this day gathers together, in the spot that witnessed so much virtue, the most select assembly that a man of genius could group round him after his death. A sovereign, as distinguished by intellectual as by moral gifts, is among us in spirit. A prince who can justly appreciate merit of every kind, by distinguishing this solemnity with his presence, desires to testify that, of the glories of Holland, not one is alien to him, and that no lofty thinking escapes his enlightened judgment and his philosophic admiration.

I.

The illustrious Baruch de Spinoza was born at Amsterdam at the time when your republic was attaining its highest degree of glory and power. He belonged to that great race which, by the influence it has exerted and the services it has rendered, occupies so exceptional a place in the history of civilization. Miraculous in its own way, the development of the Jewish people ranks side by side with that other miracle—the development of the Greek mind; for if Greece, from the first, realized the ideal of poetry, of science, of philosophy, of art, of profane life, if I may so speak, the Jewish people has made the religion of humanity. Its prophets inaugurated in the world the idea of righteousness, the revindication of the rights of the weak—a revindication so much the more violent that, all idea of future recom-

pense being unknown to them, they dreamed of the realization of the ideal upon this earth, and at no distant period. It was a Jew, Isaiah, who, seven hundred and fifty years before Jesus Christ, dared affirm that sacrifices are of little importance, and that one thing only is needful: purity of heart and hands. Then, when earthly events seemed irremediably to contradict such bright Utopias, Israel can change front in a way unparalleled.

Transporting into the domain of pure idealism that kingdom of God with which earth proves incompatible, one moiety of its children founds Christianity, the other carries on, through the tortures of the middle ages, that imperturbable protest: "Hear, O Israel! the Lord thy God is one; holy is his name." This potent tradition of idealism and hope against all hope—this religion, able to obtain from its adherents the most heroic sacrifices, though it be not of its essence to promise them any certainty beyond this life—this was the healthy and bracing medium in which Spinoza developed himself. His education was at first entirely Hebraic; the great literature of Israel was his earliest, and, in point of fact, his perpetual instructress—was the meditation of all his life.

As generally happens, Hebrew literature, in assuming the character of a sacred book, had become the subject of a conventional exegesis, much less intent upon explaining the old texts according to the meaning in their authors' minds than on finding in them aliment for the moral and religious wants of the day. The penetrating mind of the young Spinoza soon discerned all the defects of the exegesis of the synagogue; the Bible, as taught him, was disfigured by the accumulated perversions of more than 2,000 years. He determined to pierce beyond these. He was, indeed, essentially at one with the true fathers of Judaism, and especially with that great Maimonides, who found a way of introducing into Judaism the most daring speculations of philosophy. He foresaw with wondrous sagacity the great results of the critical exegesis destined, 125 years later, to afford the true meaning of the noblest productions of Hebrew genius. Was this to destroy the Bible? Has that admirable literature lost by being understood in its real aspect rather than relegated outside of the common laws of humanity? Certainly not. The truths revealed by science invariably surpass the dreams that science dispels. The world of Laplace exceeds in beauty, I imagine, that of a Cosmas Indicopleustes, who pictured the universe to himself as a casket, on the lid of which the stars glide along in grooves at a few leagues from us. In the same way, the Bible is more beautiful when we have learned to see therein —ranged in order on a canvas of a thousand years—each aspiration, each sigh, each prayer of the most exalted religious consciousness that ever existed, than when we force ourselves to view it as a book unlike any other, composed, preserved, interpreted in direct opposition to all the ordinary rules of the human intellect.

But the persecutions of the middle ages had produced on Judaism the usual effect of all persecution: they had rendered minds narrow and timid. A few years previously, at Amsterdam, the unfortunate Uriel Acosta had cruelly expiated certain doubts that fanaticism finds as culpable as avowed incredulity. The boldness of the young Spinoza was still worse received; he was anathematized, and had to submit to an excommunication that he had not courted. A very old history this! Religious communions, beneficent cradles of so much earnestness and so much virtue, do not allow of any refusal to be shut up exclusively within their embrace; they claim to imprison forever the life that had its beginnings within them; they brand as apostasy the lawful emancipation of the mind that seeks to take its flight alone. It is as though the egg should reproach, as ungrateful, the bird that had escaped therefrom. The egg was necessary in its time; when it became a bondage, it had to be broken. A great marvel, truly, that Erasmus of Rotterdam should feel himself cramped in his cell; that Luther should not prefer his monkish vows to that far holier vow which man, by the very fact of his being, contracts with truth! Had Erasmus persisted in his monastic routine, or Luther gone on distributing indulgences, they would have been apostates indeed! Spinoza was the greatest of modern Jews, and Judaism exiled him. Nothing more simple; it must have been so, it must be so ever. Finite symbols, prisons of the infinite spirit, will eternally protest against the effort of idealism to enlarge them. The spirit, on its side, struggles eternally for more air and more light. Eighteen hundred and fifty years ago the synagogue denounced as a seducer the one who was to raise the maxims of the synagogue to unequaled glory. And the Christian Church, how often has she not driven from her breast those who should have been her chiefest honor! In cases like these, our duty is fulfilled if we retain a pious memory of the education our childhood received. Let the old Churches be free to brand with criminality those who quit them; they shall not succeed in obtaining from us any but grateful feelings, since, after all, the harm they are able to do us is as nothing compared to the good they have done.

II.

Here, then, we have the excommunicated of the synagogue of Amsterdam forced to create for himself a spiritual abode outside of the home which rejected him. He had great sympathy with Christianity, but he dreaded all chains; he did not embrace it. Descartes had just renewed philosophy by his firm and sober rationalism. Descartes was his master. Spinoza took up the problems where they had been left by that great mind, but saw that, through fear of the Sorbonne, his theology had always remained somewhat arid. Oldenburg asking him one day what fault he could find with the philosophy of Descartes and of Bacon, Spinoza replied that their chief fault lay in

not sufficiently occupying themselves with the First Cause. Perhaps his reminiscences of Jewish theology, that ancient wisdom of the Hebrews before which he often bows, suggested to him higher views and more sublime aspirations in this matter. Not only the ideas held by the vulgar, but those even of thinkers on Divinity, appeared to him inadequate. He saw plainly that there is no assigning a limited part to the Infinite; that Divinity is all, or is nothing; that if the Divine be a reality, it must pervade all. For twenty years he meditated on these problems without for a moment averting his thoughts. Our distaste nowadays for system and abstract formula no longer permits us to accept absolutely the propositions within which he had thought to confine the secrets of the Infinite. For Spinoza, as for Descartes, the universe was only extension and thought; chemistry and physiology were lacking to that great school, which was too exclusively geometrical and mechanical. A stranger to the idea of life, and those notions as to the constitution of bodies that chemistry was destined to reveal—too much attached still to the scholastic expressions of substance and attribute—Spinoza did not attain to that living and fertile Infinite shown us by the science of Nature and of history as presiding in space unbounded, over a development more and more intense; but, making allowance for a certain dryness in expression, what grandeur there is in that inflexible geometrical deduction leading up to the supreme proposition, "It is of the nature of the Substance to develop itself necessarily by an infinity of infinite attributes infinitely modified!" God is thus absolute thought, universal consciousness. The ideal exists, nay, it is the true existence; all else is mere appearance and frivolity. Bodies and souls are mere modes of which God is the substance: it is only the modes that fall within duration; the substance is all in eternity. Thus, God does not prove himself; his existence results from his sole idea; everything supposes and contains him. God is the condition of all existence, all thought. If God did not exist, thought would be able to conceive more than Nature could furnish—which is a contradiction.

Spinoza did not clearly discern universal progress; the world, as he conceives it, seems as it were crystallized in a matter which is incorruptible extension, in a soul that is immutable thought; the sentiment of God deprives him of the sentiment of man; forever face to face with the Infinite, he did not sufficiently perceive what of the Divine conceals itself in relative manifestations; but he, better than any other, saw the eternal identity which constitutes the basis of all transitory evolutions. Whatever is limited seems to him frivolous, and unworthy to occupy a philosopher. Bold in flight, he soared straight to the lofty, snow-covered summits, without casting a glance on the rich display of life springing up on the mountain's side. At an altitude where every breast but his own pants hard, he lives, he enjoys, he flourishes there, as men in general do in mild and temper-

ate regions. What he for his part needs is the glacier-air, keen and penetrating. He does not ask to be followed; he is like Moses, to whom secrets unknown to the crowd reveal themselves on the heights. But be sure of this: he was the seer of his age; he was in his own day the one who saw deepest into God.

III.

It might have been supposed that, all alone on those snowy peaks, he would turn out in human affairs wrong-headed, utopian, or scornfully skeptical. Nothing of the kind. He was incessantly occupied with the application of his principles to human society. The pessimism of Hobbes and the dreams of Thomas More were equally repugnant to him. One-half, at least, of the "Theologico-Political Treatise" which appeared in 1670, might be reprinted to-day without losing any of its appropriateness. Listen to its admirable title: "Tractatus Theologico-Politicus, continens dissertationes aliquot, quibus ostenditur, libertatem philosophandi non tantum salva pietate et reipublicæ pace posse concedi, sed eamdem nisi cum pace reipublicæ ipsaque pietate tolli non posse." For centuries past it had been supposed that society rested on metaphysical dogmas. Spinoza discerns profoundly that these dogmas, assumed to be necessary to humanity, yet cannot escape discussion; that revelation itself, if there be one, traversing, in order to reach us, the faculties of the human mind, is no less than all else amenable to criticism. I wish I could quote in its entirety that admirable Chapter XX., in which our great publicist establishes with masterly skill that dogma—new then, and still contested in our own day—which styles itself liberty of conscience.

"The final end of the state," he says, "consists not in dominating over men, restraining them by fears, subjecting them to the will of others, but, on the contrary, in permitting each one to live in all possible security; that is to say, in preserving intact the natural right of each to live without injury to himself or others. No, I say, the state has not for its end the transformation of men from reasonable beings into animals or automata; it has for end so to act that its citizens should in security develop soul and body, and make free use of their reason. Hence the true end of the state is liberty. Whosoever means to respect the rights of a sovereign should never act in opposition to his decrees; but each has the right to think what he will, and to say what he thinks, provided he content himself with speaking and teaching in the name of pure reason, and do not attempt on his private authority to introduce innovations into the state. For example: a citizen who demonstrates that a certain law is repugnant to sound reason, and holds that for that cause it ought to be abrogated—if he submit his opinions to the judgment of the sovereign, to whom alone it belongs to establish and to abolish laws, and if meanwhile he acts in no wise contrary to law—that man certainly deserves well of the state as the best of citizens. . . .

"Even if we admit the possibility of so stifling men's liberty and laying such a yoke upon them that they dare not even whisper without the approba-

tion of the sovereign, never, most surely, can they be prevented from thinking as they will. What, then, must ensue? That men will think one way and speak another; that, consequently, good faith—a virtue most necessary to the state—will become corrupted; that adulation—a detestable thing—and perfidy will be had in repute, entailing the decadence of all good and healthy morality. What can be more disastrous to a state than to exile honest citizens as evil-doers, because they do not share the opinions of the crowd and are ignorant of the art of feigning? What more fatal than to treat as enemies and doom to death men whose only crime is that of thinking independently? The scaffold, which should be the terror of the wicked, is thus turned into the glorious theatre where virtue and toleration shine out in all their lustre, and publicly cover the sovereign majesty with opprobrium. Beyond question there is only one thing to be learned from such a spectacle: to imitate those noble martyrs; or, if one fears death, to become the cowardly flatterers of power. Nothing, then, is so full of peril as to refer and submit to divine rights matters of pure speculation, and to impose laws on opinions which are, or may be, subjects of discussion among men. If the authority of the state limited itself to the repression of actions while allowing impunity to words, controversies would less often turn into seditions."

More sagacious than many so-called practical men, our speculator sees perfectly well that the only durable governments are the reasonable, and that the only reasonable governments are the constitutional. Far from absorbing the individual in the state, he gives him solid guarantees against the state's omnipotence. He is no revolutionary, but a moderate; he transforms, explains, but does not destroy. His God is not indeed one who takes pleasure in ceremonies, sacrifices, odor of incense, yet Spinoza has no design whatever to overthrow religion; he entertains a profound veneration for Christianity, a tender and a sincere respect. The supernatural, however, has no meaning in his doctrine. According to his principles, anything out of Nature would be out of being, and therefore inconceivable. Prophets, revealers, have been men like others:

"It is not thinking, but dreaming," he says, "to hold that prophets have had a human body and not a human soul, and that consequently their knowledge and their sensations have been of a different nature from ours. . . . The prophetic faculty has not been the dowry of one people only—the Jewish people. The quality of Son of God has not been the privilege of one man only. . . . To state my views openly, I tell you that it is not absolutely necessary to know Christ after the flesh; but it is otherwise when we speak of that Son of God, that is to say, that eternal Wisdom of God, which has manifested itself in all things, and more fully in the human soul, and above all in Jesus Christ. Without this wisdom no one can attain the state of beatitude, since it alone teaches us what is true and what is false, what is right and what is wrong. . . . As to what certain Churches have added, . . . I have expressly warned you that I do not know what they mean, and, to speak frankly, I may confess that they seem to me to be using the same sort of language as if they spoke of a circle assuming the nature of a square."

Was not this exactly what Schleiermacher said? And as to Spi-

noza, the fellow-founder with Richard Simon of Biblical exegesis, was not he the precursor of those liberal theologians who have in our own day shown that Christianity can retain all its glory without supernaturalism? His letters to Oldenburg on the resurrection of Jesus Christ, and of the manner in which St. Paul understood it, are masterpieces which a hundred years later would have served as the manifesto of a whole school of critical theology.

In the eyes of Spinoza it signifies little whether mysteries be understood this way or that, provided they be understood in a pious sense. Religion has one aim only, piety; and we are to appeal to it not for metaphysics, but for practical guidance. At bottom there is but one single thing in Scripture, as in all revelation: "Love your neighbor." The fruit of religion is blessedness, each one participating in it according to his capacity and his efforts. The souls that are governed by reason—the philosophic souls that have, even in this world, their life in God—are safe from death; what death takes from them is of no value; but weak or passionate souls perish almost entirely, and death, instead of being for them a simple accident, involves the foundation of their being. . . . The ignorant man who lets himself be swayed by blind passions is agitated in a thousand different directions by external causes, and never enjoys true peace of soul; for him, ceasing to suffer means ceasing to be. The soul of the wise man, on the other hand, can scarcely be troubled. Possessing by a kind of eternal necessity the consciousness of itself and of God and of things, he never ceases to be, and ever preserves the soul's true peace.

Spinoza could not endure his system to be considered irreligious or subversive. The timid Oldenburg did not conceal from him that some of his opinions seemed to certain readers to tend to the overthrow of piety. "Whatever accords with reason," replied Spinoza, "is in my belief most favorable to the practice of virtue." The pretended superiority of coarsely positive conceptions as to religion and a future life found him intractable. "Is it, I ask, to cast off religion," he was wont to say, "to acknowledge God as the Supreme Good, and thence to conclude that he must be loved with a free soul? To maintain that all our felicity and most perfect freedom consists in that love—that the reward of virtue is virtue, and that a blind and impotent soul finds its punishment in its blindness—is this a denial of all religion?" At the root of all such attacks he traced meanness of soul. According to him, any one who felt irritated by a disinterested religion involuntarily confessed reason and virtue to have no charm in his eyes, and that his pleasure would lie in living to indulge his passions if he were not restrained by fear. "Thus, then," he would add, "such a one only abstains from evil and obeys the Divine commandment regretfully as a slave, and in return for this slavery expects from God rewards which have infinitely more value in his eyes than the

Divine law. The more aversion and estrangement from good he may have felt, the more he hopes to be recompensed, and imagines that they who are not restrained by the same fear as himself do what he would do in their case—that is to say, live lawlessly." Spinoza held with reason that this manner of seeking heaven was contrary to reason, and that there is an absurdity in pretending to gain God's favor by owning to him that, did one not dread him, one would not love.

IV.

He was, however, well aware of the danger of interfering with beliefs in which few admit these subtile distinctions. *Cauté* was his motto, and, his friends having made him aware of the explosion that the "Ethica" would infallibly produce, he kept it unpublished till his death. He had no literary vanity, nor did he seek celebrity—possibly, indeed, because he was sure to obtain it without seeking. He was perfectly happy—he has told us so; let us take him at his word. He has done still better: he has bequeathed us his secret. Let all men listen to the recipe of the "Prince of Atheists" for the discovery of happiness: it is the love of God. To love God is to live in God. Life in God is the best and most perfect because it is the reasonablest, happiest, fullest—in a word, because it gives us more *being* than any other life, and satisfies most completely the fundamental desire that constitutes our essence.

Spinoza's whole practical life was regulated according to these maxims. That life was a masterpiece of good sense and judgment. It was led with the profound skill of the wise man who desires one thing only, and invariably ends by obtaining it. Never did policy so well combine means and end. Had he been less reticent, he would perhaps have met the same fate as the unfortunate Acosta. Loving truth for its own sake, he was indifferent to the abuse that his constancy in speaking it entailed, and answered never a word to the attacks made on him. For his part, he attacked no one. "It is foreign to my habits," he said, "to look out for the errors into which authors have fallen." Had he desired to be an official personage, his life would no doubt have been traversed by persecution, or at least by disgrace. He was nothing, and desired to be nothing. *Ama nesciri* was his desire, as well as that of the author of the "De Imitatione." He sacrificed everything to peace of mind, and in so doing there was no selfishness, for his mind was of importance to the world. He frequently refused wealth on its way to him, and desired only what was absolutely necessary. The King of France offered him a pension; he declined. The Elector Palatine offered him a chair at Heidelberg. "Your freedom shall be complete," he was told, "for the prince is convinced that you will not abuse it to disturb the established religion." "I do not very well understand," he replied, "within what limits it would be necessary to confine that philosophical free-

dom granted me on condition of not disturbing the established religion; and then, again, the instruction I bestowed on youth would hinder my own advance in philosophy. I have only succeeded in procuring for myself a tranquil life by the renunciation of all kinds of public teaching." He felt that his duty was to think. He thought, in fact, for humanity, whose ideas he forestalled by more than two centuries.

The same instinctive sagacity was carried by him into all the relations of life: he felt that public opinion never permits a man to be daring in two directions at once. Being a freethinker, he looked upon himself as bound to live like a saint. But I am wrong in saying this. Was not this pure and gentle life rather the direct expression of his peaceful and lovable consciousness? At that period the atheist was pictured as a villain armed with daggers. Spinoza was throughout his whole lifetime humble, meek, pious. His enemies were ingenuous enough to object to this: they would have liked him to live comformably to the conventional type, and, after the career of a demon incarnate, to die in despair. Spinoza smiled at this singular pretension, and refused to oblige his enemies by changing his way of life. He had warm friends; he showed himself courageous at need; he protested against popular indignation wherever he thought it unjust. Many disappointments failed to shake his fidelity to the republican party; the liberality of his opinions was never at the mercy of events. What, perhaps, does him more honor still, he possessed the esteem and sincere affection of the simple beings among whom he lived. Nothing is equal in value to the esteem of the lowly; their judgment is almost always that of God. To the worthy Van der Spycks he was evidently the very ideal of a perfect lodger. "No one ever gave less trouble," was their testimony given some years after his death to Colerus. "While in the house he inconvenienced nobody; he spent the best part of his time quietly in his own room. If he chanced to tire himself by too protracted meditation, he would come down-stairs and speak to the family about any subject of common talk, even about trifles." In fact, there could never have been a more affable inmate. He would often hold conversations with his hostess, especially at the time of her confinements, as well as with the rest of the household when any sorrow or sickness befell them. He would tell the children to go to divine service, and, when they returned from the sermon, ask them how much they remembered of it. He almost always strongly seconded what the preacher had said. One of the persons he most esteemed was the pastor Cordes, an excellent man and good expounder of the Scriptures; sometimes, indeed, he went to hear him, and he advised his host never to miss the preaching of so able a man. One day his hostess asked him if he thought she could be saved in the religion she professed. "Your religion is a good one," he replied; "you should not seek any other, nor doubt that yours will procure salvation if, in

attaching yourself to piety, you lead at the same time a peaceful and tranquil life."

His temperance and good management were admirable. His daily wants were provided for by a handicraft in which he became very skillful—the polishing of lenses. The Van der Spycks made over to Colerus scraps of paper on which Spinoza had noted down his expenses; these averaged about fourpence halfpenny a day. He was very careful to settle his accounts every quarter, so as neither to spend more nor less than his income. He dressed simply if not poorly, but his aspect radiated serenity. It was evident that he had found out a doctrine which gave him perfect content.

He was never elated, and never depressed; the equability of his moods seems wonderful. Perhaps, indeed, he may have felt some sadness when the daughter of his professor, Van den Ende, preferred Kerkering to him; but I suspect that he soon consoled himself. "Reason is my enjoyment," he would say, "and the aim I have in this life is joy and serenity." He objected to any praise of sadness.

"It is superstition," he maintained, "that sets up sadness as good, and all that tends to joy as evil. God would show himself envious if he took pleasure in my impotence and in the ills I suffer. Rather in proportion to the greatness of our joy do we attain to a greater perfection and participate more fully in the divine nature. . . . Joy, therefore, can never be evil so long as it be regulated by the law of our true utility. A virtuous life is not a sad and sombre one, a life of privations and austerity. How should the Divinity take pleasure in the spectacle of my weakness, or impute to me, as meritorious, tears, sobs, terrors—signs all of an impotent soul? Yes," he added, emphatically, "it is the part of a wise man to use the things of this life, and enjoy them as much as possible; to recruit himself by a temperate and appetizing diet; to charm his senses with the perfume and the brilliant verdure of plants; to adorn his very attire; to enjoy music, games, spectacles, and every diversion that any one can bestow on himself without detriment to character. . . . We are incessantly spoken to of repentance, humility, death; but repentance is not a virtue, but the consequence of a weakness. Nor is humility one, since it springs in man from the idea of his inferiority. As to the thought of death, it is the daughter of fear, and it is in feeble souls that it sets up its home. . . . The things of all others," he would say, "about which a free man thinks least is death. Wisdom lies in the contemplation not of death, but of life."

V.

Since the days of Epictetus and Marcus Aurelius, no life had been witnessed so profoundly penetrated by the sentiment of the Divine. In the twelfth, thirteenth, sixteenth century, rationalistic philosophy had numbered very great men in its ranks, but it had had no saints. Occasionally a very repulsive and hard element had entered into the finest characters among Italian freethinkers. Religion had been utterly absent from those lives not less in revolt against human than divine laws, of which the last example was that of poor Vanini. Here, on the contrary, we have religion producing free thought as a part of

piety. Religion in a system such as this is not a portion of life: it is life itself. That which is seen to matter here is not the being in possession of some metaphysical phrases more or less correct: it is the giving to one's life a sure pole, a supreme direction—the ideal.

It is by so doing that your illustrious countryman has lifted up a banner which still avails to shelter beneath it all who think and feel nobly. Yes, religion is eternal; it answers to the first need of primitive as well as of civilized man; it will only perish with humanity itself—or, rather, its disappearance would be the proof that degenerate humanity was about to reënter the mere animalism out of which it had emerged. And yet no dogma, no worship, no formula, can in these days of ours exhaust the religious sentiment. We must confront with each other these seemingly contradictory assertions. Woe to him who pretends that the era of religions is past! Woe to him who imagines it possible to restore to the old symbols the force they had when they leaned upon the imperturbable dogmatism of other days! With that dogmatism we, for our part, must needs dispense; we must dispense with those fixed creeds, sources of so many struggles and divisions, but sources no less of such fervent convictions; we must give up believing that it is our part to hold down others in a faith we no longer share. Spinoza was right in his horror of hypocrisy: hypocrisy is cowardly and dishonest, but, above all, hypocrisy is useless. Who is it, indeed, that is deceived here? The persistency of the higher classes in unqualifiedly patronizing, in sight of the uncultivated classes, the religious reforms of other days, will have but one effect: that of impairing their own authority at those times of crisis when it is important that the people should still believe in the reason and the virtue of a few.

Honor, then, to Spinoza, who has dared to say: "Reason before all." Reason can never be contrary to the well-understood interests of humanity. But we would remind those who are carried away by unreflecting impatience, that Spinoza never conceived of religious revolution as being aught else than a transformation of formulas. According to him, what was fundamental went on subsisting under other terms. If he, on one hand, energetically repudiated the theocratic power of the clergy, as distinguished from civil society, or the tendency of the state to occupy itself with metaphysics, on the other hand, he never denied either the state or religion: he wished the state tolerant and religion free. We wish for nothing more. One cannot impose on others beliefs one does not possess. That the believers of other days made themselves persecutors, proved them tyrannical, but at least consistent; as for us, if we were to act as they did, we should be simply absurd. Our religion is a sentiment capable of clothing itself in numerous forms. These forms are free from being equally good; but not one of them has strength or authority to expel all others. Freedom—this is the last word of Spinoza's religious policy.

Let it be the last word of ours! It is the most honest course; it may, perhaps, also be the most efficacious and certain for the progress of civilization.

Humanity, indeed, advances on the way of progress by prodigiously unequal steps. The rude and violent Esau is out of patience with the slow pace of Jacob's flock. Let us give time to all. We may not, indeed, permit simplicity and ignorance to hinder the free movements of the intellect, but let us not either interfere with the slow evolution of less active intelligences. The liberty of absurdity in these is the condition of the liberty of reason in those. Services rendered to the human mind by violence are not services after all. That such as lay no stress on truth should exercise constraint in order to obtain outward submission, what can be more natural? But we, who believe that truth is something real, and deserving of supreme respect, how can we dream of obtaining by force an adherence which is valueless except as the fruit of free conviction? We no longer admit sacramental formulas operating by their own virtue independently of the mind of him to whom they are applied. In our eyes, a belief has no worth if it be not gained by the reflection of the individual—if he have not understood and assimilated it. A mental conviction brought about by superior order is as absolute nonsense as love obtained by force or sympathy by command. Let us promise to ourselves not only to defend our own liberty against all who seek to attack it, but, if need be, to defend the liberty of those who have not always respected ours, and who, it is probable, if they were the masters, would not respect it.

It is Holland that had the glory, more than two hundred years ago, to demonstrate the possibility of these theories by realizing them.

"Must we prove," said Spinoza, "that this freedom of thought gives rise to no serious inconvenience, and that it is competent to keep men, openly diverse in their opinions, reciprocally respectful of each other's rights? Examples abound, nor need we go far to seek them. Let us instance the town of Amsterdam, whose considerable growth—an object of admiration to other nations—is simply the fruit of this freedom. In the midst of this flourishing republic, this eminent city, men of all nations and all sects live together in most perfect concord; . . . and there is no sect, however odious, whose adepts, provided they do not offend against the rights of any, may not meet with public aid and protection before the magistrates."

Descartes was of the same opinion when he came to ask from this country the calm essential to his thinking. Later—thanks to that noble privilege of a free land so gloriously maintained by your fathers against all opponents!—your Holland became the asylum where the human intellect, sheltered from the tyrannies that overspread Europe, found air to breathe, a public to comprehend it, organs to multiply its voice, then gagged elsewhere.

Deep, assuredly, are the wounds of our age, and cruel are its perplexities. It can never be with impunity that so many problems present themselves all at once before the elements for solving them are in our possession. It is not we who have shattered that paradise of crystal, with its silver and azure gleams, by which so many eyes have been ravished and consoled. But there it is in fragments; what is shattered is shattered, and never will an earnest spirit undertake the puerile task of bringing back ignorance destroyed or restoring illusions dispelled. The populations of great towns have almost everywhere lost faith in the supernatural; were we to sacrifice our convictions and our sincerity in an attempt to give it them back, we should not succeed. But the supernatural, as formerly understood, is not the ideal.

The cause of the supernatural is compromised, the cause of the ideal is untouched; it ever will be. The ideal remains the soul of the world, the permanent God, the primordial, efficient, and Final Cause of this universe. This is the basis of eternal religion. We, no more than Spinoza, need, in order to adore God, miracles or self-interested prayers. So long as there be in the human heart one fibre to vibrate at the sound of what is true, just, and honest; so long as the instinctively pure prefer purity to life; so long as there be found friends of truth ready to sacrifice their repose to science; friends of goodness to devote themselves to useful and holy works of mercy; woman-hearts to love whatever is worthy, beautiful, and pure; artists to render it by sound, and color, and inspired accents—so long will God live in us. It could only be when egoism, meanness of soul, narrowness of mind, indifference to knowledge, contempt for human rights, oblivion of what is great and noble, invaded the world—it could only be then that God would cease to be in humanity. But far from us thoughts like these!

Our aspirations, our sufferings, our very faults and rashness, are the proof that the ideal lives in us. Yes, human life is still something divine! Our apparent negations are often merely the scruples of timid minds that fear to overpass the limits of their knowledge. They are a worthier homage to the Divinity than the hypocritical adoration of a spirit of routine. God is still in us; believe it. God is in us! *Est Deus in vobis.*

Let us all unite in bending before the great and illustrious thinker who, two hundred years ago, proved better than any other, both by the examples of his life and by the power, still fresh and young, of his works, how much there is of spiritual joy and holy unction in thoughts like these. Let us, with Schleiermacher, pay the homage of the best we can do to the ashes of the holy and misunderstood Spinoza:

"The sublime spirit of the world penetrated him; the infinite was his beginning and his end; the universal his only and eternal love. Living in holy innocence and profound humility, he contemplated himself in the eternal world, and

saw that he, too, was for that world a mirror worthy of love. He was full of religion and full of the holy spirit; and therefore he appears to us solitary and unequaled, master in his art, but lifted above the profane, without disciples, and without right of citizenship anywhere."

That right of citizenship you are now about to confer on him. Your monument will be the link between his genius and the earth. His spirit will brood like a guardian angel over the spot where his rapid journey among men came to its end. Woe to him who, in passing by, should dare to level an insult at that gentle and pensive figure! He would be punished as all vulgar hearts are punished—by his very vulgarity and his impotence to comprehend the divine. Spinoza, meanwhile, from his granite pedestal shall teach to all the way of happiness he himself had found; and for ages to come the cultivated man who passes along the Pavilioengragt will inwardly say, "It is hence, perhaps, that God has been seen most near!"—*Contemporary Review.*

TRANSMISSION OF EXCITATIONS IN SENSORY NERVES.[1]

By PAUL BERT.

PHYSIOLOGISTS are as yet by no means agreed whether the nerves which, from their special functions, have been termed *motor* and *sensor* nerves, are in their essential properties identical or different; in other words, whether a sensor nerve can transmit excitations whose result is motion, and *vice versa*. We do not even know whether an excitation produced midway in the length of a nerve is simultaneously propagated in both directions, centrifugally and centripetally. The admirable experiments made by Philipeaux and Vulpian to determine these knotty questions are, as Vulpian was the first to observe, susceptible of a different interpretation from that unanimously put upon them by the world of science.

Such being the state of the case, I thought it advisable to take up again an experiment I had made in 1863,[2] but which I had neglected to prosecute, in view of the apparently far more conclusive and far more general results obtained by the able experimenters just named. This experiment I have now completed, and strengthened against any objection that might have been raised against it.

If we pinch a sensor nerve at any point of its length, the pain that is felt clearly shows that the excitation is propagated in the centripetal direction; but of a centrifugal propagation we know nothing, for the very simple reason that at the terminal extremity of the nerve

[1] Translated from the French by J. Fitzgerald, A. M.

[2] *Comptes rendus de la Société de Biologie* (1863), p. 179.

there is no nervous apparatus of perception. But if we can bring this extremity into relation with the perceptive centre, the brain, we shall see whether there is sensation, which would imply centrifugal propagation.

The means employed in bringing about this condition of things is very simple indeed. I remove, for the length of two or three centimetres, the skin from the tip of a young rat's tail, and insert the flayed part into the subcutaneous cellular tissue through an opening made in the skin of the animal's back. A few stitches suffice to hold the parts in place, and soon they adhere firmly, the rat's tail then having the *ansate* form.

Fig. 1.—Rat with Tip of Tail inserted into the Dorsal Tissues.

Eight months later I cut the tail in two, thus leaving two caudal stubs. Immediately after section, the dorsal stub was manifestly sensitive; and when it was pinched vigorously, the rat would squeal and run off. Hence it plainly appears that, in this fragment of a tail, the excitation of the sensor nerves is propagated from the thick to the slender end, or in a direction inverse to what is held to be the normal course. The process was about as follows: the sensor nerves distributed to the extremity of the tail, on being wounded by the removal of the skin, united with the sensor nerves of the dorsal region, which in like manner had been cut into. In due course of time the nerve-cicatrix became able to transmit the shocks (whatever their nature) which an excitation produces in a nerve. When, now, we pinch the extremity of the dorsal stub, the shock is transmitted along the excited caudal nerve, passes through the cicatrix, and follows the dorso-cutaneous nerve into the spinal marrow, which carries it to the brain, where it results in a sensation of pain.

The history of the case will be readily understood on examining the following diagram, in which, for simplicity's sake, I have represented only one of the nerve-filaments of the tail (*N C*) and one of the nerve-filaments of the back (*D N*).

But this sensibility of the dorsal fragment begins to grow less on

the second day after section, and soon it is gone. If, some days later, we examine the nerves of this fragment with a microscope, we shall find that they have undergone the changes usual in nerves that have been cut off from their trophic centres; and this is true no less of the portion concealed under the skin than of the free (and certainly living) portion hanging from the animal's back: not a single sound nerve-

FIG. 2.—*M E*, spinal marrow. *N C*, nerve-filament distributed to the end of the tail. *G*, its trophic ganglion. *D N*, a nerve-filament distributed to the skin of the back, lacerated in the operation. *G*, its trophic ganglion. *C*, the cicatrix which united the two nerves, and which is now permeable to nervous shocks. *S*, point where the tail was cut in two; *a*, *b*, arrows showing the two directions in which sensory excitations are transmitted.

tube is to be seen in it. On the contrary, the stump of the tail, which has retained its natural position, has every nerve sound, with not a single diseased tube.

Thus, then, physiological facts are in agreement with histological observations, and they both prove conclusively that the sensor nerves which transmitted the centrifugal excitation were the normal nerves of the dorsal stub, and that here we have neither new-formed nerves nor nerve-fibres with ansate terminations. It is further demonstrated —and this is a fact not without interest—that the relations with the nerve-centres of perception, from which results sensation, are more easily established than those with the trophic ganglionic centres, which nourish the sensor nerves. Who knows but that, had I waited longer before I cut the tail in two, the influence of the new trophic centres would have become sufficient to maintain the nerves of the dorsal fragment in their integrity, and that sensibility would have persisted after section? Some months after the dorsal stub had become insensible, it again regained sensibility, the diseased nerves having been regenerated. At first, just as I had observed in 1863, the animal refers the impression it receives to the region of the back where the nerve-cicatrix is: this is the reverse of the illusion observed in cases of amputation. By little and little the rat is educated, and at last recognizes the exact point that is excited; thus showing that our so-called innate knowledge of the place occupied in space by every point of our bodies is, like all our knowledge, merely the result of repeated experiences.

To conclude, the experiment I have just recounted shows that excitation of a sensor nerve at any point of its length is propagated in two directions, both centrifugally and centripetally. The same is doubtless true of a motor nerve. Consequently, it is highly probable that, as Vulpian has held, the nerves are simple conductors, differentiated only by their functions, which latter depend upon the kind of apparatus at their two extremities: for motor nerves there is a motor nerve-cell and muscular fibre, and for sensor nerves a receiving nerve-cell and an impressionable termination.—*La Nature.*

ON THE PHYSICAL CONDITION OF JUPITER AND SATURN.

By DAVID TROWBRIDGE, Esq.

NOT many years ago the planets Jupiter and Saturn were regarded as solid bodies, their small relative density being supposed to be due either to the peculiar arrangement of the materials which compose them, or to the small specific gravity of the materials themselves. Within a few years, however, the nebular hypothesis has gained so strong a hold on the minds of astronomers, that the larger planets are regarded in a very different light as respects their physical condition from what they were a few years ago. It is now thought that at least Jupiter and Saturn, and probably Uranus and Neptune, have not yet cooled down from their heated and nebulous condition sufficiently to be habitable globes, and that, owing to their relatively high temperature, they have very extensive atmospheres.

It is quite possible for us to guess at the extent and density of their atmospheres, but, unless we subject our guesses to calculation, it cannot be said that they are of much use to us, since the planets are too far from us to allow direct observations to settle any points in dispute. Let us, therefore, assume Jupiter and Saturn to be globes of much higher temperature than the earth's, and that this temperature varies from the surface upward inversely as the square of the distance from the centre of the planet. Let us further assume that gases there follow the same law of expansion as terrestrial gases, and that this law holds for all temperatures above 32° Fahr. With these assumptions, it is possible for us to subject our *guesses* to calculation, and thus learn how far they are admissible.

As respects the telescopic appearance of those planets, it is plain that we have but little evidence of an atmosphere outside the highest cloud-layers. That their atmospheres extend above the highest clouds is perhaps certain; but if we attempt to explain the physical appear-

ance of those planets, the condition of the atmosphere above the clouds may be left out of the consideration. Let us assume the density of the atmosphere at the upper surface of the clouds to be equal to that of our atmosphere at the height of about fifteen miles, and we shall perhaps regard it as sufficiently rare. The height of the upper cloud-layers above the surface proper of the planets will now depend on the surface-temperature and on the mass of the atmosphere. The *law* of density for different heights above the surface of the planets is almost independent of the mass of the atmosphere, unless we consider the mass as very great in comparison with that of the planet which it surrounds.

Let us suppose the density of the atmosphere at the surface of the planet to be equal to that of water—and such a density is certainly too great for either Jupiter or Saturn—it is then possible for us to calculate the height of the cloud-layers to which we have already referred, if the temperature be given; or, if the height be given, to calculate the temperature of the surface of the planet. We have seen it suggested that, if this height be assumed equal to 2,000 miles, it will enable us to explain the telescopic appearances of Jupiter and Saturn. This height for the former planet requires a surface-temperature of 45,000°, and for the latter 20,000° Fahr. It seems to be quite evident that these temperatures are much too high. That Jupiter and Saturn give out more light than they receive from the sun, seems nearly certain; but a temperature of 20,000° would seem to imply a much greater intrinsic splendor than either Jupiter or Saturn possesses.[1]

Prof. Proctor, in one of his articles, assumes the height of the highest cloud-layers to be 100 miles above the surface of the planet. This implies a temperature of 1,800° for the surface of Jupiter, and of 600° for that of Saturn. We must now conclude that the cloud-layers which form the outlines of the disks of Jupiter and Saturn are scarcely 100 miles high on Saturn, and considerably less on Jupiter; for we have assumed the surface-density much too high, and probably the density of the upper cloud-layers much too small. We cannot certainly consider the temperature of either planet above 2,000° Fahr.

The Herschelian figure of Saturn can probably be explained by the surface cloud-layers in its atmosphere. We need a greater number of and more careful observations on Jupiter and Saturn.

[1] These calculations are based on a mathematical paper read before the American Philosophical Society, November 3, 1876.

SKETCH OF ALFRED RUSSEL WALLACE.

ALFRED RUSSEL WALLACE, an English naturalist, was born at Usk, Monmouthshire, January 8, 1822. He was employed for several years in the architectural office of his brother, and then devoted himself to natural history. In 1848 he accompanied Mr. H. W. Bates in a scientific expedition to Brazil, where, after a protracted sojourn in Pará, he explored the primeval forests of the Amazon and Rio Negro, returning to England in 1852. His valuable collections, especially rich in the departments of ornithology and botany, were in great part destroyed by shipwreck. In 1853 he published "Travels on the Amazon and Rio Negro" and "Palm-Trees of the Amazon and their Uses," and in 1854 undertook a journey to the East Indies, where for a period of nearly eight years he explored the greater part of the islands constituting the Malay Archipelago, and portions of Papua. While pursuing his researches relative to the fauna and flora of these regions, Mr. Wallace, unaware of Darwin's previous labors in the same direction, attempted the solution of the problem of the origin of species, and arrived at almost the same general conclusions which were simultaneously reached by that naturalist. His paper "On the Tendency of Varieties to depart indefinitely from the Original Type," transmitted through Sir Charles Lyell to the Linnæan Society, was read before that body on July 1, 1858, coincidently with the reading of Mr. Darwin's paper "On the Tendency of Species to form Varieties, and on the Perpetuation of Species and Varieties by means of Natural Selection." Though recognizing the efficacy of natural selection in producing most of the changes attributed to its action by Mr. Darwin, he denies its competence to effect, without the joint agency of some higher cause, the transition to man from the anthropoid apes. In 1862 Mr. Wallace returned to England, where for several years he was mainly engaged in the classification of his vast collection, which embraced upward of 100,000 entomological specimens, and more than 8,000 birds. The results of his Eastern explorations were partially embodied in "The Malay Archipelago: the Land of the Orang-utan and the Bird-of-Paradise" (1869). Mr. Wallace has of late been prominently associated with the believers in the so-called spiritualistic phenomena, to the examination of which he has devoted special attention. His observations were published in a series of essays in the *Fortnightly Review* for 1874, reprinted as "Miracles and Modern Spiritualism" (1875). In 1868 he received the royal medal from the Royal Society, and in 1870 the gold medal from the Geographical Society of Paris. In 1870 he published "Contributions to the Theory of Natural Selection." His elaborate work "On the Geographical Distribution of Animals" (2 vols.) appeared in 1876 in English, French, and German.

CORRESPONDENCE.

A CURIOUS SALINE DEPOSIT.

To the Editor of the Popular Science Monthly.

SIR: A singular natural phenomenon has recently come under my observation. As I have never heard of it before, and as it appears almost incredible to all who have heard me speak of it, I thought it well to give it publicity through the columns of your monthly.

During the present month, while out on a scouting expedition, I spent three days in Deep Spring Valley, a lonely place in the White Mountains in Inyo County, California. During one day of my stay, the 5th of March, I found that the Indians were catching wild aquatic birds of all sorts in Deep Spring Lake by simply wading into the water and seizing them with the hands. The birds, at that time, had their plumage so heavily coated with a saline compound that they were totally unable to fly, and thus fell an easy prey to the savages. On inquiry, I was told that this salt formed on the birds' breasts and wings, so as to prevent flight, only during a very short season of the year, and then under a peculiar combination of circumstances. The season lasts from about the first of March to the middle of April, and the birds can only be caught from dawn until about nine o'clock in the day, when the previous night has been perfectly clear, with a gentle wind from the north. The birds are then found in the southern part of the lake, incrusted with the salt. On the first night that I spent there the sky was cloudy and the wind was from the north; on the third night the sky was clear and the wind was from the south, and no ducks were caught on the following morning; and from my own observation I can say that none were incrusted. But during the second night of my stay the conditions were exactly favorable, and ducks were caught in abundance next day. In 1875 I visited the same locality in the month of December, and neither heard nor saw anything of this mode of catching water-fowl.

I weighed one duck immediately after it was caught, with all the incrustation intact, and again when the salts were cleaned off, and found that the latter weighed six pounds. The duck seemed to have been drowned by its burden; its eyes and bill were completely closed by a large lump of the salt.

Some small fresh streams enter the lake at the northern end; and on the favorable nights the Indians take the precaution to build fires and hang out cloths at the mouths of these streams, to prevent any of the ducks from entering the fresher water and thus having the salty incrustation dissolved or washed off. During these favorable nights, also, the Indians collect on the southeastern shore of the lake and perform a duck-dance, in which they artistically imitate the motions, habits, and calls, of different kinds of water-fowl. Throughout my entire sojourn on the shores of the lake, its shallow waters were rendered turbid by the wind; but they were equally turbid with a south as with a north wind.

As the lake of which I speak is the only one known to these Indians where ducks may be caught in this manner, it may be well to describe it more particularly. It lies in a desert valley, 6,200 feet above the sea. It is about one mile in length from north to south, and about three-quarters of a mile wide from east to west. Its average depth does not exceed three feet, although there are a few deeper holes in it. The land around is sandy, and covered with "sage-brush." During the past summer the Indians took from the bottom of the lake several tons of salt, which was sold to quartz-mills in this neighborhood as chloride of sodium, sufficiently pure to be used in the reduction of ores. It is said that the amount obtained in two days was fourteen tons; but this estimate may be taken, in more senses than one, *cum grano salis*.

I send you a specimen of the salt, which I gathered myself from one of the ducks, and am very anxious that you would have it analyzed.

W. W. WOTHERSPOON,
Lieutenant Twelfth U. S. Infantry.

CAMP INDEPENDENCE, INYO CO., CAL., *March* 15, 1877.

The following analysis, made by Dr. Elwyn Waller, of the School of Mines, Columbia College, gives the composition of the deposit above referred to:

*Sulphate of soda	57.37 per cent.
*Sulphate of potash	8.09 "
Chloride of potassium	0.89 "
Carbonate of lime	2.94 "
Carbonate of magnesia	2.50 "
Sand and clay	10.41 "
Moisture	16.30 "
Bicarbonate of soda	(trace) "
Organic matter	2.32 "
	100.05

FERMENTATION AND DISEASE.

To the Editor of the Popular Science Monthly.

PROF. TYNDALL'S lecture on "The Relation of Fermentation to Putrefaction and

* Calculated from the data afforded by the weight of the combined sulphates, and a determination of the sulphuric acid present.

Disease" explains so many phenomena which I have noticed, that I am disposed to accept it with avidity. Nevertheless, there seem to be some contradicting facts. Once, when serving with a troop of cavalry, a young and apparently healthy beef was brought to us, which we slaughtered, and set about cooking immediately. To our surprise, the flesh was tainted. To the senses of taste and smell the taint could not be distinguished from incipient putrescence. A careful examination failed to detect any signs of disease in the entrails or any part of the animal. The time which elapsed from the killing of the beef until the flesh was tasted was only a few minutes, certainly not half an hour. It was in Louisiana, in the month of April, late in the evening, and in cool weather; notwithstanding unprejudiced stomachs and resolute appetites, we were obliged to desist, and make a hungry camp.

Another instance, and much more incompatible with the bacterial theory of putrefaction as set forth by Prof. Tyndall, I find in Dr. Kane's narrative of his Arctic expedition. I have not the work at hand to refer to the page, but it is where, in the early dawn of the arctic morning, he watched several times for a reindeer which had been indistinctly seen, in the faint light, haunting a valley about a mile or two from the ice-bound ship. He finally succeeded in killing it, and his men ate one meal; but the carcass putrefied before they could eat again. This, and the temperature of the air many degrees below zero! He goes on to say that the sudden putrefaction of meat in the arctics is common; that sometimes a bear or a deer would spoil before it could be flayed. Can it be that there are arctic bacteria?—that in warmer countries there are exceptional kinds which hasten putrefaction at such a rate? Can it be that the cells of the flesh in certain circumstances produce putrefaction, somewhat as the cells of fruit produce fermentation? Or, finally, is it so that, both in the case of Dr. Kane's reindeer and in that of my beef, the animal had eaten something which gave the flesh a bad flavor, and our imagination supplied much more than we supposed? The facts need some explanation, and, in the case of Dr. Kane, are of such weight as should challenge the general attention of observers.

M. M. KENNEY.

BRENHAM, TEXAS, *March* 25, 1877.

THE ORIGIN OF HONEY-DEW.

To the Editor of the Popular Science Monthly.

DEAR SIR: Mr. Darwin says, in his last work, "Cross and Self Fertilization in the Vegetable Kingdom," page 402: "Many years ago I suggested that, primarily, the saccharine matter in nectar was excreted as a waste product of chemical changes in the sap; and that, when the excretion happened to occur within the envelopes of a flower, it was utilized for the important object of cross-fertilization, being subsequently much increased in quantity and stored in various ways. This view is rendered probable by the leaves of some trees excreting, under certain climatic conditions, without the aid of special glands, a saccharine fluid, often called honey-dew." In the mountains of North Carolina there is a species of honey-dew eagerly sought for by bees, which is rarely seen by persons who have written of it, and is by many supposed to be a myth; but Mr. Rufus Morgan, one of the best informed and most successful apiarians of that section, who has for several years examined it in all its stages, is convinced that it is an animal, not a vegetable exudation. In reply to my questions respecting it, he writes:

"The phenomenon is not only well known in my section of the State, but is of annual recurrence. I have frequently studied it on green leaves, generally in the month of June or July, and invariably found it in close vicinity to the well-known aphides, or plant-lice, always below them, whence I concluded they wounded the leaves and caused this sap or 'honey' to flow. But, on further examination, I was fortunate enough to witness an actual shower of dew, in almost infinitesimal globules; and, on getting the sunlight at the right angle, these particles could be traced to these little creatures.

"It was a perfectly quiet day, and they seemed to eject the globules with some force, making them fly clear of the leaf and fall on the leaves below. Of course, such small particles would be wafted away by even a gentle wind, and, not being accompanied by their cause, their origin would necessarily be obscure.

"Last spring, before any leaves were out, I witnessed a most extraordinary yield of it on the pines. It hung in great drops, and fell off like real dew when the branches were shaken. At first I was mystified as to its origin, as I could find no aphides, which, according to my theory, ought to be present; but on a closer inspection I found them in abundance, not on the green, but on the dark or woody part of the twig. As these little insects are of the same color as the substance on which they are found, they are noticed only by close observers; but there is no doubt in my mind that the honey-dew is an exudation from them. These insects are also called 'ant-cows,' from the fact of ants seeming to suck them, when they are only gathering this sweet secretion. It will be hard to convince the public of this simple origin of the honey-dew, as, of the hundreds with whom I conversed respecting it last year, none would accept my views,

except the few whom I took to the trees and showed the philosophy of it, and even they seemed to regret that I had spoiled a pet delusion."

In his "Origin of Species," page 97, Mr. Darwin, in speaking of the inability of the hive-bee to suck nectar from the red-clover flowers, says: "I have been assured that when red clover has been mown, the flowers of the second crop are somewhat smaller, and that these are visited by many hive-bees. I do not know whether this statement is accurate, nor whether another published statement can be trusted, namely, that the Ligurian bee, which is generally considered a mere variety, and which freely crosses with the common hive-bee, is able to reach and suck the nectar of the common red clover."

Both of these statements Mr. Morgan confirms, and, acting on the fact that the Ligurian or Italian bee can procure honey not only from the red clover but other flowers of his section, in which the nectar is inaccessible to the common or black bee, he has Italianized his whole apiary by crossing the black and Ligurian bees, and finds the cross stronger and better honey-gatherers than the common bee. These facts, as coming from a practical apiarian, may be interesting to the readers of THE POPULAR SCIENCE MONTHLY, and therefore I have ventured to send them to you. M. B. C.

NEW BERNE, NORTH CAROLINA.

EDITOR'S TABLE.

THE POPULAR SCIENCE SUPPLEMENTS.

TWO great tendencies of modern thought are every year more and more marked: one relating to its character, and the other to the form of its expression. The thinking of the age is taking a scientific direction, and becoming more profoundly imbued with the scientific spirit, while the leading minds of all nations are contributing their choicest work for periodical publication. Not only are old sciences perfecting and new ones arising with a rapid development of positive knowledge, but the method of the movement is steadily extending to all spheres of opinion, and influencing important questions with which it was long supposed that science had nothing to do. It is one of the marked effects of the recent growth and diffusion of the scientific spirit that it is giving a new earnestness and seriousness to literary effort, bringing forward questions of universal interest into greater prominence, and inducing in the most eminent minds a desire to communicate more directly and immediately with the people, by the readiest modes of publication. Hence, in England, France, and Germany, as well as in this country, the best thought appears in the popular magazines. A further result of this tendency to earnestness, in recent periodical writing, is that authors are taking the responsibility of their work before the public, by attaching their names to their magazine contributions. The old and vicious system of anonymous writing in the reviews is declining, and giving place to the open, manly, and honest expression of the writer's convictions. Through the operation of such causes, periodical literature is acquiring a weight and influence in our time much greater than it has ever had before.

THE POPULAR SCIENCE MONTHLY was established in recognition of these tendencies, and to make the vigorous, valuable, and independent intellectual work of the age, wherever done, more accessible to American readers. We have drawn, for our articles, from foreign sources, because science is of no nationality, and it is an obvious dictate of common-sense to get the best things wherever they are to be had. This policy has been approved by the public, and now, after ten volumes have appeared, we find our limits so inadequate that an increase of facilities becomes necessary to secure the object for which the magazine was started.

So many excellent things have been constantly slipping by us for which there was no room in the pages of THE MONTHLY — so many sterling papers which our readers would prize, and have often called for—that we find ourselves now compelled to resort to the issue of supplements in order to accomplish the purpose at first had in view. The volumes that we have thus far furnished undoubtedly contain the largest amount of varied and valuable mental work to be found within equal limits in any periodical of any country, and we now intend to increase its scope and influence by the help of these supplementary issues, so as to meet the augmenting requirements of the times, and make this publication the completest reflection of the scientific and philosophic progress of the age that can be anywhere obtained. It will represent the course of contemporary thought on subjects of leading interest, preserve its most permanent elements, and form a comprehensive and independent scientific library, well suited to the wants of non-scientific people.

During the ensuing year THE POPULAR SCIENCE SUPPLEMENTS will appear once a month, containing, each, ninety-six pages, price twenty-five cents; and they will contain the freshest and most important articles that appear abroad, of the same general character as the past contents of THE POPULAR SCIENCE MONTHLY. Objection has sometimes been made that THE MONTHLY is high-priced, but it has been furnished as cheaply as the nature of the enterprise would allow. There is no maxim of trade more sound and practical than that value must be paid for, and that the lowest-priced goods are always the poorest, and but rarely the cheapest. Quality should certainly be taken into account in our mental nutriment if anywhere, and THE POPULAR SCIENCE MONTHLY and its SUPPLEMENTS will furnish the cheapest first-class reading in the United States.

JEVONS ON "CRAM."

PROF. JEVONS has contributed an article to *Mind* (copied into THE POPULAR SCIENCE SUPPLEMENT, No. 1), in which he attempts a defense of "cram" in connection with the system of competitive examinations. Such is the working of that system, and so inevitably does it lead to cramming, that it is not difficult to see either that the system must be abandoned or "cram" defended; and Prof. Jevons intrepidly takes the latter alternative. We admire his pluck but condemn his logic. Clear thinker as he is, in this brilliant and specious paper he has simply confused an important subject in the interest of a questionable cause.

He makes his case by drawing a distinction between two sorts of "cram," which he calls "good cram" and "bad cram." He says: "A candidate, preparing for an important competitive examination, may put himself under a tutor well skilled in preparing for that examination. The tutor looks for success by carefully directing the candidate's studies into the most 'paying' lines, and restricting them rigorously to those lines. The training given may be of an arduous, thorough character, so that the faculties of the pupil are stretched and exercised to their utmost in those lines. This would be called 'cram,' because it involves exclusive devotion to the answering of certain examination-papers. I call it 'good cram.'

"'Bad cram,' on the other hand, consists in temporarily impressing upon the candidate's mind a collection of facts, dates, or formula, held in a wholly undigested state, and ready to be disgorged in the examination-room by an act of mere memory. A candidate unable to appreciate the bearing of Euclid's reasoning in the first book of his 'Elements,' may learn the propositions off by heart—diagrams, letters, and all—like a Sunday-scholar learning

the collects and gospels. Dates, rules of grammar, and the like, may be 'crammed' by mnemonic lines," etc.

We object to this distinction. "Bad cram" means a great deal more than Prof. Jevons here indicates; and his "good cram" is either "bad cram" or no "cram" at all. He is mistaken in limiting what he calls "bad cram" to loading the memory with formula without understanding principles, as in the illustration he offers of Euclid's "Elements." It is possible to "cram" the apprehension of a subject as well as its verbal forms. We knew a young lady in one of our leading academies, the only female student in a geometry-class of twenty, who, under the spur of feminine vanity, kept her position at the head of the class for the whole term, giving the demonstrations every time when the gentlemen broke down, and having the clearest understanding of the subject which such a prolonged ordeal compelled, while the whole experience amounted to nothing for permanent effect. The boasted discipline was a pure illusion. She lived for a whole term in a sort of atmosphere of geometrical excitement, and upon leaving the school the mathematical fever subsided and the geometry disappeared like a dream. It was a case of pure "cram." Time was not taken for digestion—for the deepening of acquisition and the consolidation of mental habits. "Cram" refers not so much to any form or kind of acquisition (although some favor it more than others), but rather to the rate of any acquisition. Its essential element is excessive and unnatural forcing—a stuffing of mental aliment, that may be excellent in itself, but out of relation to natural appetite or healthy assimilation. Prof. Jevons says that the epithet "cram" affords an admirable "cry" for the opponents of the examination-system; that "it is short, emphatic, and happily derived from a disagreeable physical metaphor;" by which he probably means that its metaphorical use in education is derived from a disagreeable physiological experience. But is its mental application really so metaphorical, after all? One may eat so as to keep pace with the digestive and assimilative processes of the system, or he may exceed that rate in taking food, which is cramming. But is not mental acquirement also based on physiological activity, and subject to a time-rate depending upon cerebral assimilation? The "cram" of the dining-room and the "cram" of the school-room are, at bottom, the same thing, merely involving different physiological organs.

Prof. Jevons, indeed, yields this point explicitly. He concedes the physiological basis of mental culture, in saying: "It is the very purpose of a *liberal education*, as it is correctly called, to develop and train the plastic fibres of the youthful brain so as to prevent them taking too early a definite 'set,' which will afterward narrow and restrict the range of acquisition and judgment." But if it is plastic fibres and cells that we have at last to deal with, what escape is there from the conclusion that true education — the leading out of the faculties—must take its rate from the measured processes of nervous growth?

Prof. Jevons's "good cram" is defined as arduous and thorough study directed to the winning of honors at a competitive examination. But thorough study, carried on under the conditions favorable to enduring acquisition, is not "cram" of any sort, because the term in its essential meaning excludes thoroughness. We shall not deny that much vigorous, persistent intellectual work may be accomplished under competitive inspiration, in which no "cram" is involved; and we think Prof. Jevons commits a harmful error in applying the term "cram" to such study, and undertaking to qualify it by an adjective that simply neutralizes it. Under such an authoritative sanction, all

"cram" will become "good cram," and a plausible excuse be thrown over one of the most extensive vices of education.

Prof. Jevons's object is to defend competitive examinations; and there is a painful significance in the fact that he admits the system to be so involved and bound up with the practice of "cram," that nothing remains but to wrest the word from its established meaning, and give it a new and respectable meaning. His tactics are ingenious, but nothing is gained by them. However the words are altered, the facts will remain.

Prof. Jevons strives to strengthen his view by carrying it out into the application of practical life, which he maintains to be little else than a sphere of incessant "cram." He says: "The actual facts which a man deals with in life are infinite in number, and cannot be remembered in a finite brain. . . . . In some cases we require to remember a thing only a few moments or a few minutes; in other cases a few hours or days; in yet other cases a few weeks or months; it is an infinitesimally small part of all our mental impressions which can be profitably remembered for years. Memory may be too retentive, and facility of forgetting and of driving out one train of ideas by a new train is almost as essential to a well-trained intellect as faculty of retention." He then goes on to say that the lawyer, the physician, the merchant, "deal every day with various combinations of facts which cannot all be stored up in the cerebral framework, and certainly need not be so. . . . . The practical barrister 'crams' his brief;" and "what is 'cram' but the rapid acquisition of a series of facts, the vigorous getting up of a case?"

Now the upshot of all this is, that in life we have constantly to make temporary acquisitions, and which often require vigorous exertion. But will it be pretended that the making of temporary acquisitions is the legitimate work of education? A lawyer may "cram" his case, but if he succeeds with it he must not have crammed his law. There is undoubtedly a varying value in mental acquisitions; some are not worth retaining, and others are of lasting importance. But there are facts, truths, principles, that should be indelibly engraved upon the minds of students: these should be the staple of education, and be the means of that deliberate discipline which it is the chief object of education to impart. Our educational system is virtually at fault in not having yet organized a curriculum in which acquisitions of permanent value are made fundamental. Prof. Jevons says: "If things taught at school and college are to stay in the mind, to serve us in the business of life, then almost all the higher education yet given in this kingdom has missed its mark." Exactly; and for this reason the system is under sharp arraignment, and a "new education" is demanded. Prof. Jevons's assertion that many things are not worth retaining in the mind, naturally leads to the vital question, "What knowledge is of most worth?" To make his argument good, that knowledge may be crammed because of its worthlessness, he must show that no knowledge is worth retaining, and all is to be stuffed with a view to getting rid of it.

A BASELESS RUMOR.

The Rev. Moncure D. Conway writes gossipy letters from London to the *Cincinnati Commercial*, and in his eagerness for sensational statements, as is usually the case with gossips, is quite too careless of their truth. He has started the story that the closing portions of Mr. Herbert Spencer's "Principles of Sociology" are so loosely and badly written as to indicate that Spencer is showing a decline of his mental powers. This has created anxiety in the minds of many, and we have re-

ceived various inquiries as to what ground there is for Mr. Conway's statement.

It is true that Mr. Spencer has not been in good health, and has been compelled recently to desist from labor, and it is this circumstance that just now operates to give point to Conway's opinion; but it is to be remembered that Mr. Spencer's health was not so good when he began his philosophical system in 1860 as it has been since; while in writing "First Principles" he was often compelled to stop work, and go to the country for rest and reinvigoration.

As to the evidence of mental failure to be gathered from the work on Sociology just published, we do not observe that anybody else besides Conway has found it. The volume has been widely reviewed by leading English periodicals, and none of them, that we have seen, share the discernment of the correspondent of the *Cincinnati Commercial*. On the contrary, they testify to the sustained power and originality of his work, and are more concurrent and emphatic than ever before as to Mr. Spencer's capacity to carry forward the gravest and profoundest intellectual undertaking of the age. It is, moreover, the views developed toward the close of the volume that have made the strongest impression upon the minds of the critics. They see, in his treatment of the questions there discussed, especial indications of that wide grasp and subtile analysis which have been so marked a characteristic of his previous philosophical volumes. We print elsewhere a portion of the notice of "The Principles of Sociology" that appeared in the London *Examiner*, and it will be seen that, in referring to these very views, brought out at the close of the book, the writer remarks, "It strikes us that Mr. Spencer here exhibits an increased power of seizing the many influences which contribute to a complex result." To do this in a vast field of comparatively unexplored phenomena is certainly the highest test of intellectual vigor. It is admitted by those who have reviewed the book most thoughtfully, that the ideas reached and developed by Spencer in its concluding portions are certain to exert a powerful influence in modifying the course of current opinion, and that they will give a new direction to controversies that will call out the best effort of the leading thinkers of our time.

Mr. Spencer has continued his exposition in a chapter to be appended to the volume of Sociology, of which we give in the present number of the MONTHLY the first installment. To those who are solicitous about his breaking down mentally, we commend the perusal of this paper, and the conclusion of it, which will appear next month. Having disposed in the volume of Mr. Max Müller and his followers, who were overdoing the myth-business, he now takes up the social doctrines of Sir Henry Sumner Maine. This able writer maintains a theory of social development in which the starting-point is the patriarchal system. Mr. Spencer holds that this view is philosophically defective, as it assumes a certain social condition without accounting for it, by investigating the anterior and still lower conditions of social relation. Each one will be his own judge, after reading the argument, as to its validity against Sir Henry Maine's view; we call attention to it here only for the benefit of those who are concerned about the truth of Mr. Conway's statement.

LITERARY NOTICES.

SIX LECTURES ON LIGHT. Delivered in America in 1872–'73. By JOHN TYNDALL, D. C. L., LL. D., F. R. S. Second edition. New York: D. Appleton & Co. Pp. 264. Price, $1.50.

VARIOUS opinions were passed at the time upon Prof. Tyndall's choice of a subject for his American lectures, and also upon his treatment of it. Some complained

that he had chosen a branch of physics so well settled as that of light, and thought that he ought rather to have entered into some of the exciting phases of modern scientific controversy. Others complained that he dealt with the subject in so elementary a manner, and thought he ought to go into it with a profundity commensurate with his reputation, and such as would afford an adequate excuse for his leaving home and going so far away to instruct a foreign people. For we may just as well acknowledge that there was a great deal of narrowness and illiberality in the view taken of Tyndall's errand, and which was by no means confined to the laity. There was an ill-suppressed jealousy on the part of some of our scientific men, which made them captious in regard to the lectures, and which gave weight and currency to objections that from other sources would have been regarded as frivolous and unworthy of notice. It would have been far easier for Prof. Tyndall to have taken up some of the recent controversial topics, in which the public takes so deep an interest, and read a series of discourses that would have drawn crowds to his lecture-room, instead of encumbering himself with tons of apparatus, and bringing along experienced assistants to make his lectures thoroughly experimental and demonstrative for large popular audiences. But his choice of a subject, and his method of treating it, have been abundantly vindicated. He presented the leading principles of optics in a striking and impressive manner, and as connected and interpreted by the undulatory theory of light, with various lessons and applications in regard to the uses of scientific theory, and the motives of scientific research, which the topic was so well suited to enforce. Tyndall's American lectures form incomparably the best popular exposition of the wave-theory of light to be found in any language, and for this purpose it will long hold its place as a standard book. Accepting the public approval of the work for this purpose, as evinced by the several editions that have been called for, Prof. Tyndall has carefully revised it, made some important additions, and substituted new and superior illustrations, so that the edition which now appears, although faithfully presenting the lectures as they were delivered, has very much the aspect of a new work. He has prefixed to the volume a fine steel engraving, by Mr. Adlard, of Dr. Thomas Young, whose position in modern physics he holds to be only second to that of Newton, and in a full appendix of instructive notes and extracts he has incorporated the addresses of President Barnard, Dr. Draper, President White, and his own remarks, at the Tyndall banquet which followed the close of his lectures in New York. In his preface to the second English edition, now republished here, Prof. Tyndall remarks as follows of the object he had in view in preparing the American lectures: "I have sought to raise the wave-theory of light to adequate clearness in the reader's mind, and to show its power as an organizer of optical phenomena. From what has been recently written on such questions, it is to be inferred that the origin, scope, and warrant of physical theories generally, constitute a theme of considerable interest to thoughtful minds. On these points I have ventured, particularly in the second and third lectures, to state the views which my own reflections have suggested to me. To produce a systematic treatise on light was, of course, quite wide of my aim. My desire, rather, was to throw into a small compass an exposition for which I should have been grateful at a certain period of my own studies. I wished, in the first place, as the prime condition of all satisfactory progress, to clear the reader's mind of all indistinctness regarding elementary facts and conceptions, and to whet incidentally the desire for further knowledge. I wished, moreover, for the sake of that numerous portion of the community who are interested in the material results of science, to trace effects to their causes, by showing how such results receive their primary vitalization from the thoughts of men with no material end in view. The 'Summary and Conclusion,' which might be read as an introduction, is for the most part devoted to this object."

FACTS AND FANCIES ABOUT FISH: THE NEW YORK AQUARIUM. New York: D. Appleton & Co. Pp. 15.

THIS little pamphlet is Part I., No. 1, of a series of popular natural history monographs by Mr. W. S. Ward, naturalist of

the New York Aquarium, and contains a very readable and instructive account of the natural objects that are to be seen at that meritorious institution. It is profusely illustrated with capital cuts by Beard, Church, Kelley, and others. It is Mr. Ward's purpose to publish these parts from time to time, as circumstances warrant, with the hope that they will meet with such a demand as will lead to a periodical issue—a hope which will soon be realized if his endeavor meets with the success it deserves.

ESSAYS ON POLITICAL ECONOMY. By FRÉDÉRIC BASTIAT. English translation revised by David A. Wells. New York: G. P. Putnam's Sons. Pp. 291. Price, $1.25.

AMONG the modern political writers who have labored to vindicate liberty of trade and to expose the fallacies and economical failures of protection, Bastiat in many respects stands unrivaled. Other men may perhaps have gone deeper into the philosophy of the subject, or contributed more toward the establishment of political economy as a body of scientific principles, but no man has done so much as Frédéric Bastiat to explain and illustrate its truths, and enforce them upon the popular mind. A thorough master not only of the subject but of the art of lucid, attractive, and telling statement, his economical essays are well worth reading, if only for their literary effect. Many writers can make reading pleasant if allowed to choose their themes. Political economy has long been proverbial for its dry, statistical repulsiveness—has long been known as "the dismal science;" but in the hands of Bastiat it is as far as possible from being either dry or dismal. Mr. Wells, the editor of the present work, gives the following account of it in his preface to the American edition:

"This little volume is made up of a selection from the essays of M. Bastiat, that have in a high degree these popular and attractive characteristics; such as a presentation of the nature of capital and interest, and the relation of the two; a discussion, under the title, 'That which is seen and that which is not seen,' of the evils that always result from limiting consideration of the effect of an economic law, tax, or institution, to its immediate visible influence, and ignoring its ultimate consequences, introducing, in so doing, the illustration which has passed into many languages, of 'The Broken Window;' also the questions of 'What is Government?' 'What is Money?' and the nature, object, and function of what is popularly and generally termed 'the law,' without reference to any particular code or statute. So acceptable, indeed, have these short, selected essays proved to the public, that repeated editions of them have been published in France, Belgium, Germany, Italy, England, and the United States; and all that the editor has had to do with the present American edition has been to revise the previous English translation, which was exceedingly imperfect, and in some instances absolutely without meaning. Where the text—which was originally written to meet the condition of affairs in France at the time of the overthrow of the monarchy and the establishment of the republic in 1848—could be changed verbally with advantage to meet the different condition of men, laws, and things, at present existing in the United States, such changes have been made, English names being substituted for French ones, dollars and cents in place of francs and sous, and the like. A few notes pertinent to the subject-matter of the text, and drawn mainly from the recent economic experience of the United States, have also been added."

THE EFFECTS OF CROSS AND SELF FERTILIZATION IN THE VEGETABLE KINGDOM. By CHARLES DARWIN, M. A., F. R. S. New York: D. Appleton & Co. Pp. 482. Price, $2.

THE name of the author upon this title-page is an assurance that the book is a solid contribution to the advance of that branch of biology which may be named philosophical botany. It is the result of a long series of elaborate, painstaking inquiries into that curious and mysterious field of organic activity, the process of fertilization in plants. The inquiry is hardly popular, and will only have its deepest interest to those who know something of the technicalities of botany. Yet Mr. Darwin has prefixed to the volume an excellent chapter of introductory remarks, which will prove generally intelligible and instructive; and there are but few who will read this chapter and not be lured forward by the attractive and fascinating import of the discussion. The author also adds a very important chapter of general results, in which he states the practical bearing of the inquiry as respects the art of the agriculturist and horticulturist. His discussion is at the basis of the problem and the intelligent practice of breeding. He furthermore points out its great theoretical significance to the scientific inquirer, who aims to go as

deep as possible into the question of Nature's economy in continuing, diversifying, and giving stability to the course of life upon our globe.

AN ALPHABET IN FINANCE. A Simple Statement of Permanent Principles and their Application to Questions of the Day. By GRAHAM MCADAM. New York: G. P. Putnam's Sons. Pp. 210. Price, $1.25.

"THIS little book," we are told in the preface, "was written as a political duty;" and it would be a blessing to long-suffering listeners and readers if every one who feels a "call" to preach or to write was as well fitted for the task he undertakes as Mr. McAdam. He has succeeded in treating the elementary principles of finance briefly and at the same time clearly, simply, and effectively; and his discussion of the commoner fallacies and often-repeated stock arguments of the inflationists is so good, that it is to be hoped the book will find a circulation among them. The chapters on "Money a Creation of Government," "Pure Credit Money," "What is a Specie Basis?" "Banking"—all brief—are models of statement in their way. Although the author apparently accepts Mr. Jevons's views as to the word *value*, the somewhat ambiguous way in which he uses that term makes the chapter on "The Qualities of Gold for Money" slightly obscure, which is to be regretted, for much of the success of inflation arguments is rooted in the hazy notions concerning what is called the *value* of gold. We would call the author's attention to the statement on page 130, that "$4.444 still remains by custom the nominal par" (of exchange), the fact being that the nominal and real par have been in agreement, at $4.866, both by usage and United States statute for two years or more.

REPORT OF THE GEOLOGICAL SURVEY OF INDIANA, 1875. By E. T. COX, State Geologist. Pp. 599. With Maps and Plates.

DURING the year 1875 the general work of the survey of Indiana was carried on in nine counties: Vigo, Huntington, Jennings, Ripley, Orange, Vanderburgh, Owen, Montgomery, and the southeastern part of Clay. A special reconnaissance was made of the coal-measure rocks of Putnam County; also a special hydrographic survey of some of the lakes in the northern portion of the State. Besides the results of these researches, the report contains observations on fossil marine plants from the coal-measures, by Mr. L. Lesquereux, and a catalogue of the Wabash Valley flora, by Dr. J. Schenck.

IVANHOE. By SIR WALTER SCOTT. Also OUR MUTUAL FRIEND. By CHARLES DICKENS. New York: Holt & Co. Pp. 350. Price, $1.

THESE little volumes belong to the "Condensed Classics" series. The text is absolutely identical with the original works, except that much of the less essential matter of the latter has been omitted. If any one thinks an acquaintance with all the leading writers of his language to be necessary, he *must* resort to condensations like this. Life is not long enough to enable a man to read our entire "polite literature" through.

ANNUAL REPORTS OF THE ZOÖLOGICAL SOCIETY OF CINCINNATI, for the years 1874–'75–'76. Cincinnati: printed for the Society.

IT is to be regretted that an enterprise containing so much spirit should not as yet have proved a pecuniary success. The following is interesting: "In Europe there are now [1874] in operation, or in process of construction, more than eighty zoölogical gardens, and, almost without exception, they are profitable, and in some cases largely so. The experience in Philadelphia is encouraging, while that of the garden in San Francisco is . . . . marvelous." Strange that the last report contains no list or statement of the animals!

DAVID AND ANNA MATSON. By ABIGAIL SCOTT DUNIWAY. Pp. 194. With Illustrations. New York: S. R. Wells & Co. Price, $2.

INASMUCH as it does not lie within our province to estimate the value of works of the imagination, we will only say of this volume that its theme is the "tender passion," in one of its many phases; that the verses are smooth and musical enough, and that the mechanical make-up of the book is admirable as regards print, paper, and binding.

QUALITATIVE CHEMICAL ANALYSIS. A Guide to the Practical Study of Chemistry and of the Work of Analysis. By SILAS H. DOUGLAS and ALBERT B. PRESCOTT, of the University of Michigan. New York: D. Van Nostrand. Second edition, revised. Pp. 254. Price, $3.50.

THIS excellent work has grown out of the exigencies of chemical teaching. In its earliest form it appeared in 1864, and passed through several editions. It was intended to be used, with Fresenius's "Manual of Qualitative Analysis," as a guide to the experimental study of substances to be made in connection with analysis, but beyond its immediate requirements. It is now revised and enlarged so as of itself to answer the needs of the student, and relieve him from the necessity of obtaining more than one text-book for inorganic qualitative work. Its aim is stated to be, "to aid the student in gaining an accurate acquaintance with the facts whereby analyses are made; and a clear understanding of the coördination of these facts—the principles of analysis—has been the chief object of this work. It is the result of experience in the constant endeavor to prevent habits of automatic operation and of superficial observation in analysis." Various improvements in the work are pointed out in the preface to the new edition, which have been arrived at by the experience of the last ten years, and which bring the volume up to the requirements of the times.

THE CHEMIST'S MANUAL. A Practical Treatise on Chemistry, Quantitative and Qualitative Analysis, Stoichiometry, Blowpipe Analysis, Mineralogy, Assaying, Toxicology, etc. By HENRY A. MOTT, Jr., E. M., Ph. D. New York: D. Van Nostrand. Pp. 625. Price, $6.

THIS work is designed not for popular reading, but for practical students of chemistry, and will answer the purpose of a kind of condensed library of technical information, in which the ordinary text-books are deficient. Compiled by a working student, from the needs of his own experience, it cannot fail to be useful to others in similar circumstances, who will find the labor here done to their hand which they would otherwise have to do for themselves. The author has prepared the work on the principle that every scientific man "should compile his own pocket-book, as he proceeds in study and practice, to suit his particular business." Having accumulated from time to time a large number of valuable notes, tables, and chemical data, which became too voluminous to be carried in the pocket, he then decided to extend, systematize, and publish them. Dr. Charles F. Chandler, Professor of Chemistry in the Columbia College School of Mines, introduces the work by a brief preface, in which he says:

"This carefully-prepared 'Manual' of Dr. Mott will prove especially valuable as containing a judicious selection of the most important methods, most of which have been tested by laboratory experience, and found to give satisfactory results. These are presented in a concise form, with reference to original authors. The numerous tables of constants will also be found of great value. This work will possess a special value for the student and laboratory-worker, and will serve as a useful reference-book for the general scientific reader."

Mr. Van Nostrand has got the work out in excellent style, and we have only to make a small complaint of the inartistic monotony of the page-headings, which simply reproduce the title of the book, without giving any guidance to its successive subjects and the variety of its contents.

THE MICROSCOPIST. A Manual of Microscopy and Compendium of the Microscopic Sciences, with 205 Illustrations. By J. H. WYTHE, A. M., M. D., Professor of Microscopy and Biology in the Medical College of the Pacific, San Francisco. Philadelphia: Lindsay & Blakiston. Pp. 259. Price, $4.50.

DR. WYTHE'S manual first appeared twenty-five years ago, and he now issues the third edition, rewritten and greatly enlarged. In regard to his object in preparing the volume, the author says: "It is proposed in this treatise to give such a *résumé* of microscopy as shall enable the student in any department to pursue original investigations with a general knowledge of what has been accomplished by others. To this end a comprehensive view of the necessary instruments and details of the art, or what the Germans call technology, is first given, and then a brief account of the application of the microscope to various branches of science, especially considering the needs of physicians and students of medicine." The sciences here referred to are

micro-mineralogy, micro-chemistry, biology, histology, and pathological histology. The work is clearly written, and its matter presented systematically and in very judicious proportions. It contains a great number of beautifully-colored plates, which will prove helpful to the student. In an introductory chapter on the history and importance of microscopy, Dr. Wythe points out the many ways in which this art has proved useful to man in recent times. The following suggestion, however, we had not met with before, and we trust it will incite religious people to buy microscopes and learn to use them: "Even theology has its contribution from microscopy. The teleological view of Nature, which traces design, receives from it a multitude of illustrations. In this department the war between skeptical Philosophy and Theology has waged most fiercely; and if the difference between living and non-living matter may be demonstrated by the microscope, as argued by Dr. Beale and others, Theology sends forth a pæan of victory from the battlements of this science."

MICHIGAN BOARD OF HEALTH. Fourth Annual Report (1876). Pp. 250. Lansing: W. S. George & Co. print.

IN addition to the journal of the proceedings of the board, and sundry details of administration, we have here a great deal of matter of general interest: such as statistics of diseases, remarks on illuminating oils, studies of typhoid fever, etc. Among the more voluminous essays, we may mention papers on means of escaping from public buildings in case of fire, vaccination, scarlet fever, criminal abortion, water and water-supply, ventilation of railroad-cars, etc.

REPORT OF THE COMMISSIONER OF EDUCATION FOR THE YEAR 1875. Pp. 1,189. Washington: Government Printing-Office.

IN the personal report of Commissioner Eaton, which occupies the first 170 pages of this volume, is found an instructive retrospect of the history of popular education in this country, together with a general review of the present status of primary and superior instruction, both in the United States and in other countries; then follow voluminous abstracts of the reports of school officers throughout the States and Territories of the Union; and, finally, we have 22 tables of school statistics, giving information with regard to such matters as normal schools, higher schools for women, colleges, scientific schools, public libraries, museums of art and natural history, institutions for the blind, deaf and dumb, and idiots, educational benefactions, etc. The value of the information here conveyed is no doubt very considerable, and it is much enhanced by the addition of a good index.

HOW TO CAMP OUT. By JOHN M. GOULD. New York: Scribner, Armstrong & Co. Price, $1.

THIS is the best work of the kind ever published. Mr. Gould is the author of a "Regimental History of the War," which received the highest commendation from the New York *Nation* and *Evening Post*. He has camped in every way, and, being a man of the keenest observation and possessed with the orderly faculty of noting down everything, has given in this book advice and suggestion of the greatest value to those who go on camping or tramping expeditions. Sound information is given regarding food, clothing, boots and shoes, knapsacks, tents, and huts of various kinds, with valuable hygienic advice from Dr. Elliott Coues's writings. A pleasant vein of humor runs through its pages; and to those who never stir out of the city, the book will be found entertaining as well as camp-provoking.

SPENCER'S PRINCIPLES OF SOCIOLOGY.

THE following notice of this important work is from the review in the London *Examiner*: "The appearance of Mr. Spencer's first volume on 'The Principles of Sociology' will be a matter of rejoicing to that large and growing number of readers whose minds have been deeply impressed and roused to new reflection by the writer's masterly exposition of the philosophy of evolution. This feeling of joy will only be tempered by the regret which Mr. Spencer's readers will certainly experience on learning, from a notice appended to the volume, that disturbed health has obliged him to desist when about to write certain conclud-

ing chapters to this present volume, and that, in his opinion, 'it may be some time—possibly months—before he is able to resume work at his ordinary, slow rate.' Still, this regret should not unduly depress us, seeing that we have now in our hands a bulky volume of over 700 pages, in which the author lays down the principal foundation-lines of his scientific structure. Most of Mr. Spencer's admirers, perhaps, have looked forward to the doctrine of social evolution as the most valuable and interesting result of the author's labors. It is quite natural, indeed, that many, to whom the unfamiliar conceptions of biology and the abstruse subtilties of psychology are somewhat repellent, should look forward to the promised exposition of sociology, with its more familiar ideas of industry, religion, government, etc. To this it may be added that, just now, there is a large concentration of scientific interest on all historical problems, and many who were indifferent to the first principles of matter and motion will look with eagerness into the present volume for its theory of social progress. It may at once be said that all who have anticipated this work will find in it ample intellectual material of the most interesting sort. The author here takes us far enough to enable us to see how his previous volumes have been leading up to a clear and scientific conception of society and its laws—far enough, too, for us to discern the revolution which the theory of evolution is to effect in many current notions respecting social phenomena. . . .

"Mr. Spencer's theory of primitive ideas seems to us so much the most important element in the volume that we have dwelt on it at length, to the neglect of the other parts. Of what remains, only a very few words can be said. After completing his account of the data of psychology, the author passes to his Second Part, which has for its theme 'The Inductions of Sociology.' Under this head Mr. Spencer discusses the nature of society as an organism, the ideas of social growth, social structures and functions, and the division of the social organism into three systems of organs, namely, the sustaining, the distributing, and the regulating, answering to those of digestion, circulation, and nervous coördination, in the individual organism. The analogy between a society and a bodily organism is worked out with remarkable ingenuity, according to the sketch given by the author in the popular introduction to sociology already alluded to. Mr. Spencer succeeds, we think, in establishing the closeness of this similarity, and, what is more, in showing how it arises from the fundamental similarity of the processes of evolution underlying individual and social growth. Thus, for example, the curious analogy in the distributing systems of the two kinds of organism between the up and down lines of railway and the veins and arteries, is seen, on reflection, to be something more than an accidental coincidence. At the same time, Mr. Spencer appears to us to have become more clearly aware of the limits of this analogy, and of the circumstances which mark off social aggregates from single, living organisms.

"After thus determining the data and leading principles of sociology, Mr. Spencer proceeds, in his Third Part, to deal with social phenomena themselves — that is to say, the movements or processes which make up social development. He begins with the domestic relations, the account of which brings the volume to a close. We have no space left to follow the author in his interesting review of the gradual development of monogamy out of the primitive relations of the sexes. His views on the nature of marriage without the tribe and marriage within the tribe (exogamy and endogamy), of polyandry, and polygamy, and of their relations of coexistence and sequence, rest in part on the researches and conclusions of writers like Mr. McLennan, while in some important particulars they deviate from this writer's theories. It strikes us that Mr. Spencer here exhibits an increased power of seizing the many influences which contribute to a complex result. The highly-interesting character of this part, as of the whole volume, makes us look forward to the continuation of this work on 'Sociology,' which, we strongly suspect, to judge by the little progress already made, is going to be much more voluminous than the works on 'Biology' and 'Psychology.' May the author's health speedily allow him to carry forward his great enterprise!"

PUBLICATIONS RECEIVED.

The Poultry Yard and Market: a Practical Treatise on Gallinoculture, and Description of a New Process for hatching Eggs and raising Poultry. By Prof. A. Corbett. New York: Orange Judd & Co. 1877. Pp. 96. Price, 50 cents.

Shade-Trees, Indigenous Shrubs, and Vines. By J. T. Stewart, M. D. And Insects that infest them. By Miss Emma A. Smith. Peoria: *Transcript* Co. print. 1877. Pp. 55.

The People *vs.* Daniel Schrumpf; Misdemeanor, Adulteration of Milk; Argument of W. P. Prentice, Counsel to the Board of Health, for the Prosecution. New York: J. F. Trow & Son print. 1877. Pp. 32.

Coördinate Surveying. By Henry F. Walling, C. E. Published by the American Society of Civil Engineers. 1877. Pp. 19, Three Plates.

Religion and Science; The Psychological Basis of Religion considered from the Standpoint of Phrenology. A Prize Essay. New York: S. R. Wells & Co. 1877. Pp. 35. Price, 20 cents.

On Some Derivatives of Diphenylamine. By Dr. P. Townsend Austen. Reprint from *American Journal of Science and Arts*. Pp. 11.

Second Annual Report of the Inspector and Assayer of Liquors to the Commonwealth of Massachusetts. By Prof. J. F. Babcock. Boston: Albert J. Wright print. 1877. Pp. 39.

On the Ethers of Uric Acid; Contributions from the Laboratory of Harvard College. By H. B. Hill. Reprinted from *American Journal of Science and Arts*. Pp. 11.

Lubrication. By Prof. R. H. Thurston. Reprinted from the *Polytechnic Review*. Pp. 4.

Note on the Sensation of Color. By C. S. Peirce. Reprint from *American Journal of Science and Arts*. Pp. 5.

Publications of the Cincinnati Observatory, Nos. 2, 3. Mitchel's Micrometrical Measurements of Double Stars. Pp. 18 and 34.

Laboratory Notes from the University of Cincinnati. By F. W. Clarke. Reprint from *American Journal of Science and Arts*. Pp. 6.

History of the Discovery of the Circulation of the Blood. By W. J. Conklin, M. D. Reprinted from Ohio *Medical and Surgical Journal*. Pp. 14.

On Puerperal Septicæmia. By J. W. Underhill, M. D. Cincinnati: Aldine Printing-Works. 1877.

Field and Forest; a Monthly Journal devoted to the Natural Sciences. Edited by Charles R. Dodge. Vol. II., Nos. 7, 8, 9, and 10. Price $1 a year.

The Development of the Animal Kingdom; a Paper read at the Fourth Meeting of the Association for the Advancement of Women. By Graceanna Lewis. Nantucket: Hussey & Robinson print. 1877. Pp. 21.

Monthly Reports of the Kansas State Board of Agriculture for February and March, 1877. By Alfred Gray, Secretary. Topeka.

Transactions of the Wisconsin Academy of Sciences, Arts, and Letters. Vol. III. 1875–'76. Madison: E. B. Bolen print. Pp. 269.

Van Nostrand's Science Series. No. 28: Transmission of Power by Wire Ropes. By Albert W. Stahl, M. E. Pp. 124. No. 29: Steam Injectors, their Theory and Use. By M. Léon Pochet. Pp. 79. New York. 1877. Price, 50 cents each.

Strength and Calculation of Dimensions of Iron and Steel Constructions. By J. J. Weyrauch. Ph. D. New York. 1877. Pp. 112, with Four Folding Plates. Price, $1.

Linear Perspective. Part I. By F. R. Honey. New Haven, Conn.: Judd & White. 1877. Pp. 35, Nine Plates. Price, $1.25.

Report of the Board of Health of the City and Port of Philadelphia for the Year 1875. Pp. 351.

United States Geographical Surveys west of the One Hundredth Meridian. Appendix JJ of the Annual Report of the Chief of Engineers for 1876. By Lieut. George M. Wheeler. Washington: Government Printing-Office. Pp. 343, accompanied by Seven Topographical Atlas Sheets.

Report of the Secretary of the Navy. 1876. Pp. 336.

Annual Report of the Chief Signal Officer to the Secretary of War, for 1876. Pp. 509, with numerous Weather Maps.

POPULAR MISCELLANY.

Proposed Scientific Expedition around the World.—For some months Mr. James O. Woodruff, of Indianapolis, has been busily engaged in organizing a "scientific expedition around the world," the object of which is to visit points of general and special interest, to study architecture, archæology, geology, and the fauna and flora of new or little known localities, and to make collections and studies in natural history generally.

It is proposed to start from New York some time next fall, in a steamship of a thousand tons, officered by experienced men from our navy, and fitted with all the appliances necessary for such an expedition. Ten scientific professors, selected from the faculties of our leading universities, are to go along in the capacity of teachers, giving lectures and instruction in the various subjects of study.

The island of Marajo, at the mouth of the Amazon, Valparaiso, some of the less known islands of the Central Pacific, New Guinea, Borneo, Ceylon, and Alexandria, are a few of the more prominent points it is proposed to visit; the ship returning by the way of France and England. Inland excursions, for the purposes of exploration and the collection of specimens, will be a feature of the expedition. Eighty students can be accommodated. The trip is expected to consume two years, and will cost each student, according to published estimates, about $5,000.

Fruit-Farming in England.—The home-supply of fruit in England being very inadequate to the demand, foreign fruit has to be imported in enormous quantity. Hence the price of fruit is very high, and the great

mass of the population have to deny themselves this wholesome form of nutriment. The London Society of Arts has undertaken the investigation of the question of fruit-growing, and is laboring to awaken a popular interest in the matter. In this country fruit is cheap and abundant, yet many of the suggestions made on the other side of the Atlantic would not be out of place even here. In one of the papers read before the Society of Arts, it is stated that only 40,000 acres of land are set apart in England for market-gardens. Considering what enormous crops of fruit are obtained from this inconsiderable acreage, how shall we estimate the product of waste lands were they to be cultivated? The market-gardens, as we have seen, cover less than 60 square miles; but the railway embankments represent about 200 square miles of land, one-third of which, at least, could be used for the cultivation of fruit. The little plots of ground attached to cottages in the country and in villages and suburban districts might also be utilized for fruit-growing. Road-sides in the country might also be cultivated profitably. The prospect of success in this effort at enlarging the area of fruit-culture in England is not very encouraging, owing to the unthriftiness of the people. In this respect they compare very unfavorably with their neighbors, the French.

Frequency of Color-Blindness.—There is some reason for believing that writers on "color-blindness" have in many instances exaggerated with regard to the frequency of its occurrence. Thus it has been stated as a fact that no less than ten per cent. of the railroad engine-drivers in Sweden are unable to announce properly the color of the signal-lamps, owing to color-blindness. Mr. Herbert W. Page, surgeon to the London and Northwestern Railway, is of the opinion that, so far from being common, this affection is extremely rare. He cites the testimony of three railway examining surgeons in support of his views. One of these, who in the course of twenty-five years had examined many hundreds of men, writes that color-blindness "is of excessive rarity;" another "has not found it common;" while a third, a surgeon of long experience, writes that he has met with "only three cases of well-marked color-blindness" among many hundreds examined by him. In 800 men examined by Mr. Page himself, not one instance of true color-blindness was found. Similar testimony is given by Dr. Macaldin, of the Midland Railway.

How, then, are we to account for the positive statements of other writers who assert the extreme frequency of this affection? In very many cases ignorance of the *names* of colors is, doubtless, mistaken for inability to distinguish between colors themselves. Then, many persons are hesitating and slow in their recognition of colors. "Green may be spoken of as blue by one, red as green by another, and the name persisted in till the man be asked to compare the one before him with some familiar color, as the grass or sky, when his mistake will be recognized at once. I cannot help thinking," adds Mr. Page, "that such cases as these have often been mistaken as instances of color-blindness. It certainly is within my own experience, that errors of this kind may creep in unawares *unless time and care be given to the examination of those who are ignorant, stupid, or nervous.*"

Marsh-Fevers.—A substantial addition to our knowledge of the true nature of paludic fevers appears to have been made by Messrs. Lanzi and Terrigi, of Rome. Lanzi has found in the cells of microscopic algæ from the Roman marshes certain dark-green granules, which are most numerous when the plants are farthest gone in decomposition. At length these granules fill the cells, are black under the microscope, and the algæ emit an offensive odor. In the Campagna marshes are formed in winter, which in spring develop algæ abundantly. In summer the water disappears, and the algæ then putrefy, the ground afterward growing phanerogamous plants. Toward the fall of the year the algæ in the parts still covered with water also die, and the slime at the bottom of the marshes contains quantities of the dark granules. The latter may also arise from other plants in the state of decay, even where there are no marshes. Lanzi regards these granules as a sort of ferments. Now, the pigment-granules found in the liver and spleen of individuals suffering from malaria have quite similar properties to

those ferment-granules, and they can be developed quite similarly. M. Terrigi has specially devoted himself to the means of disinfection, which may prevent the decaying process and development of the granules; he found chloride of lime, lime, and chloral, the most efficacious. With aspirators and air-filtering apparatus he ascertained that the germs rose to a height of fifty centimetres (about twenty inches) above the marsh-bottom, where they could easily be carried away by the winds. M. Terrigi found the "malaria-melanin" (as they call it) abundant in the liver and spleen of Guinea-pigs that had breathed the marsh-air for some time.

How the Chinese go a-Fishing.—Under the title "Fishing Extraordinary" a writer in *Chambers's Journal* describes various singular devices used in different countries for catching fish. Some portions of the narrative are calculated to put a strain upon the credulity of the reader, as, for instance, when we are informed that "the lakes and rivers of China, and especially of the north, are so abundantly stocked with fish, that in some places the men called fish-catchers make their living by actually seizing and drawing them out with their hands." If any of our readers should happen to dwell in the vicinity of such fish-abounding streams, they will be pleased to learn how these fish-catchers set about their work. Here is the *modus operandi:* The man goes into the water, and proceeds, half walking, half swimming, raising his arms above his head and letting them drop, striking the surface with his hands. Meanwhile his feet are moving on the muddy bottom. Presently he stoops with a rapid dive and brings up a fish in his hand. His object in striking the surface is to frighten the fish, which, when alarmed, sink to the bottom; then the naked feet feel them in the mud, and, once felt, the practised hand secures them in a moment.

Another Chinese method of fishing described by this writer is very ingenious. It is usually practised at night, and depends upon a peculiar power which a white screen, stretched under the water, seems to possess over the fishes, decoying them to it and making them leap. A man sitting in the stern of a long, narrow boat, steers her with a paddle to the middle of a river, and there stops. Along the right-hand side of his boat a narrow sheet of white canvas is stretched; when he leans to that side it dips under the surface, and, if it be a moonlight night, gleams through the water. Along the other side of the boat a net is fastened, so as to form a barrier two or three feet high. The boatman keeping perfectly still, the fish, attracted by the white canvas, approach and leap, and would go over the narrow boat and be free in their native waters on the other side, but for the screen of netting, which stops them and throws them down before the man's feet.

The Use of Anti-Ferments.—To prevent fermentation, a wine-grower in New Jersey added to a twelve-gallon keg of new wine about one gramme (15½ grains) of salicylic acid, or a very little more than the minimum quantity as given by Neubauer. Soon the wine lost its natural flavor, and acquired a flavor something like that of camphor. A sample of this altered wine having been submitted to Dr. Endemann for examination, he at once referred the new flavor to the presence of salicylic ether. In a communication to the American Chemical Society, Dr. Endemann writes: "The formation of this ether may be understood if we regard the circumstances. The wine was only one year old, and could not be considered ripe and ready for sale, and should therefore have received not the minimum quantity but rather more salicylic acid, to entirely prevent after-fermentation. The quantity, therefore, being insufficient, salicylic acid came in contact with alcohol *in statu nascendi*, which caused this abnormal action. Wine-growers are naturally very suspicious of chemicals, and are therefore very apt to make the same mistake—that is, they prefer to use the minimum quantity; and I should not be surprised if similar experiences had followed the application of this substance in other places."

Determination of Copper.—Mr. J. M. Merrick, of Boston, proposes a new method of determining very small quantities of copper. It is intended as a supplement to Bergeron and l'Hôte's colorimetric test, which fails to

indicate a quantity of copper less than 0.5 milligramme. Mr. Merrick's method consists simply in concentrating to a very small bulk the solution suspected to contain copper, and then depositing the copper, if present, upon platinum, by the battery. He uses for a depositing-cell a very small test-tube, on a foot cut off, so as to give a vessel about one and a half inch deep. Into this is introduced the solution acidified with sulphuric acid, and a platinum anode and cathode—each about an inch long and one-eighth inch or less wide—are hung face to face, and very close together; and, the circuit being completed, very satisfactory deposits of copper are obtained with incredibly minute quantities of the metal. The amounts are determined by the increased weight of the cathode (which is provided with a platinum wire soldered on with gold, by which it can be hooked to a balance) and on the loss of weight of the same after washing with nitric acid. The platinum is polished and heated red-hot before the first weighing, and then gently heated before hanging in the solution. The contrast in color between deposited copper and bright platinum is, of course, striking and characteristic. In this way, 0.1 milligramme of copper may be, the author thinks, safely determined; while for mere qualitative analysis this method may be employed where the amount is even smaller.

Award of the Bigsby Medal to Prof. O. C. Marsh.—Prof. P. Martin Duncan, President of the Geological Society of London, in announcing the award of the Bigsby Medal to Prof. O. C. Marsh for his services in investigating the paleontology of the *Vertebrata*, paid a high but well-merited compliment to the learned Yale professor. Said Prof. Duncan: "He has distinguished himself by studying the fossil remains of nearly every great group of the vertebrata from the palæozoic, cretaceous, and cainozoic strata of the New World. The field of his research has been immense, but it has been very correct; and his descriptive and classificatory paleontological work indicates his effective grasp of anatomical details, and his great power as a comparative osteologist." Prof. Duncan then enumerated in some details the chief lines of research pursued by Prof. Marsh, and was followed by Mr. Hulke, himself a paleontologist, who heartily approved all that had been said by the president with respect to the value of Prof. Marsh's services to paleontology. "These," he said, "are so numerous and important as to mark an epoch in this line of research. The present recognition of the value of his labors will doubtless prove an incentive to fresh work."

What is Moderate Drinking?—The advocates of total abstinence from intoxicating liquors are wont to condemn even a moderate use of stimulating drinks, on the ground that "moderate drinking is the parent of excessive drinking." The *Lancet* questions the correctness of this proposition, but in its negative definition of what is meant by "moderate" drinking the votaries of Bacchus will find very little comfort. "The man," says the *Lancet*, "who begins the day with a 'soda-and-brandy,' has very little respect for his constitution, and if he does not alter his habits, they will alter his health. Odd glasses of beer and glasses of spirit in a forenoon do not come within the range of moderate drinking. That is not moderate drinking which adds fifteen or twenty beats to the pulse, or which flushes the face. Finally, all casual drinking is bad, presumably, and not moderate drinking. The system will not receive food merely as a matter of conviviality, at all sorts of odd hours. Still less will it receive with impunity drink in this way. Drinking which disturbs sleep, either by making it heavy or by driving it away, is not moderate. Moderate drinking is that which consists with a clean tongue, a good appetite, a slow pulse, a cool skin, a clear head, a steady hand, good walking-power, and light, refreshing sleep. It is associated with meals, and is entirely subordinated to more convenient and less objectionable forms of food. That such drinking produces drunkenness, has yet to be proved, as it has yet to be proved to be essential to health."

Retention of Impressions by the Retina.—Does the retina retain in death the image last impressed upon it? That such is the case has been asserted, but hitherto the evidence has not been satisfactory, to say

the least. But recent experiments made by Prof. Kühne, of Heidelberg, appear to show that the image does remain. He took a rabbit and fixed its head and one of its eyeballs at a distance of about five feet from a small opening in a window-shutter. The head was covered for five minutes with a black cloth and then exposed for three minutes to a somewhat clouded mid-day sky. The rabbit was then instantly decapitated; the eyeball which had been exposed was extirpated in yellow light, then opened and instantly plunged into a weak solution of alum. Two minutes after death the second eyeball, without removal from the head, was subjected to exactly the same processes. On the following morning the retinæ of both eyes were carefully isolated, separated from the optic nerve, and turned. They exhibited a nearly square, sharp image, with sharply-defined edges.

Extirpation of our Larger Mammals.—In a paper on the extirpation of our larger indigenous mammals, published in the *Penn Monthly*, Mr. J. A. Allen remarks that the larger, the less sagacious, or the otherwise more easily-captured species, have always been the first to be destroyed. The walrus, being hunted for its ivory and its oil, soon became extinct in the Gulf of St. Lawrence; the bison wholly disappeared east of the Mississippi (south of Wisconsin) prior to the year 1800; the moose and the caribou were early pressed back into the remoter northern forests; and the elk everywhere quickly disappeared before the advancing settlements. Formerly abundant from the Great Lakes nearly to the Gulf coast, its sole survivors east of the Mississippi for the last few decades have been confined to the least frequented parts of the Alleghanies, where few, if any, still survive. Thirty years ago it was abundant over nearly all of the prairies, plains, and mountain valleys of the Great West, where it is now confined within comparatively narrow boundaries, and its present rapid rate of decrease portends its speedy total extirpation south of the forty-ninth parallel. The Virginia deer, once a common denizen of the whole eastern half of the United States, now scarcely exists in New England south of the forests of Maine and Northern New Hampshire, or in New York south or west of the great Adirondack Wilderness, or anywhere in the Middle States away from the mountains. It has also disappeared from a large part of the Atlantic coast-region farther southward, and from the greater part of the area between the Great Lakes and the Tennessee river. The bear, the panther, the gray wolf, and the lynx, have become similarly restricted. The fisher, the marten, and the Canada porcupine, former inhabitants of the northern parts of the northern tier of States, as well as of the Appalachian highlands to or beyond Virginia, have only here and there a few lingering representatives in the least frequented parts of the mountains, and are much more rare than formerly in the forests of Northern New England and the great unsettled region north of the St. Lawrence. The same is true of the beaver, except that it had a much more extended range to the southward, being a former inhabitant of Northern Florida and the middle and northern portions of the Gulf States, and of all the intervening region thence northward.

Psychic Phenomena.—Mr. Sergeant Cox, in a letter to the London *Spectator*, made the assertion that no one who had investigated "psychic phenomena" ever had "come to any other conclusion than that they were real." To this Moncure D. Conway replies as follows:

"I beg to inform that gentleman that I have for more than twenty years, both in the United States and in England, and in the presence of well-known mediums as well as private circles, diligently investigated the subject, and I have never seen any phenomena at all worthy of notice, except such as indicate the audacity of some persons and the weakness of others."

Extending the Meat-Supply.—One of the most enthusiastic hippophagists of Paris, M. Decroix, not content with advocating the use of horse-flesh for food, now would have people eat the flesh of diseased animals. He has made it a practice to eat the flesh of horses killed in his service, which had glanders or farcy, and, whether thoroughly or partially cooked, he found no evil results to his health. Further,

ever since 1861 he has eaten the flesh of all animals that have died within his reach, no matter from what disease. He affirms that one may eat with impunity the flesh, cooked (not putrid), of any of the domesticated animals, no matter what they died of—glanders, typhus, hydrophobia, etc. So far from the flesh of animals which have died naturally having a repugnant appearance or a peculiar flavor, he states that he has placed the two kinds side by side in the same pan and with the same sauce, and, in serving to different persons, many of them connoisseurs, the meat of animals that have died a natural death has invariably been pronounced superior to that from the slaughter-house!

New Test of Death.—The importance of having some readily-applied and indisputable test of the fact of death is apparent, and many are the processes that have been offered to determine it. Nevertheless, such a test appears to be still a desideratum—unless, indeed, we accept that offered by Kappeler. In the course of his researches on the electrical stimulation of dead muscles, Kappeler subjected twenty corpses to the action of various electric currents, noting the times of disappearance of contractility. In persons emaciated by chronic maladies, it disappeared much more rapidly than in well-nourished individuals, or those who had had acute disease. It disappeared seventy-five minutes after death at the quickest, and six and a half hours at the slowest. In cases where a rise of temperature is observed after death electric contractility persists longest. So long as there remains the least flicker of life the contractions continue intact. In the most prolonged faints, in the deepest lethargies, in poisoning by carbonic oxide, chloroform, etc., there is contraction so long as life lasts. But if the muscles make no response to the electrical stimulation, Kappeler pronounces life to be extinct.

Voracity of the Trout.—A correspondent writing from Au Sable Forks, New York, communicates to THE MONTHLY the following very remarkable instance of voracity in a trout: While he and another gentleman were fishing in a stream near the place of his residence, they came to a "long still hole," into which his companion dropped a hook and line, and immediately after pulled up a trout measuring about nine inches. The trout had swallowed the hook, and, in trying to extricate it, the fish's mouth, throat, and stomach, were found to be almost filled with a snake. They pulled the animal out and threw it on the bank; it had evidently been recently killed. "We did not measure the snake," writes our correspondent, "but each of us estimated its length at fourteen inches. We took," he adds, "about a dozen more trout from the same hole, which seemed to show that this enormous meal had not made the trout in the least sluggish, or dulled the edge of his appetite; for if it had, some of the smaller fish would have taken the bait before him."

Deaths from Inhalation of Chloroform.—In communicating to the Cincinnati Academy of Medicine a list of deaths by chloroform occurring in that city and its vicinity, Dr. Charles Anderson recognizes a "strange fatality" attending the use of the drug in Cincinnati. No other city in the United States numbers so many deaths from this cause; yet, perhaps, if all the chloroform casualties of other cities had been duly recorded, Cincinnati would no longer hold this bad preëminence. The author calls attention to a singular anomaly observed in the action of this anæsthetic, viz., that many of those who have died from chloroform have taken it repeatedly, and often for a considerable time, without any unpleasant symptoms, whereas an attempt to give it a short time afterward has proved fatal. Thus one patient, who had taken it frequently during ten years, died from forty drops; another had taken it a hundred times, and had once been under its influence for five hours; the last dose, which was fatal, consisted of an inhalation or two from a chloroformed handkerchief. After citing other similar instances, Dr. Anderson, whose communication we find in the *Clinic*, expresses the opinion that in these cases there exists a sort of floating idiosyncrasy—one that may have hold of a man for an hour or an instant. "It may be on him to-day," adds the author, "and off to-morrow; but if, while under its influence, he inhale the vapor of

chloroform, he is almost sure to die. I was on the point of saying, if he inhale the *slightest* quantity of the vapor of chloroform, it will prove fatal. I am almost convinced that that would not be putting it too forcibly. When you consider the remarkably small quantity given in all the cases, I think you will be inclined to say that there is something in the theory."

NOTES.

DR. ELLIOTT COUES, U. S. Army, the distinguished naturalist of the Hayden Surveys, and one of the most eminent ornithologists in the country, has just been elected Professor of Anatomy in the National Medical College in Washington. He entered upon its duties in April, and chose for the subject of his inaugural lecture, "Anatomical Science in its Bearings on the Origin of Species and Man's Place in Nature." He took strong grounds for the truth of evolution, and claimed the right to seek and state "the truth of Nature as existing in matter, with no heed to possible results, and without regard to the dictation of dogma, the sensibilities of prejudice, or the fears of ignorance."

THE Summer School of Science, inaugurated last year at Bowdoin College, is to be continued this season, the term to commence July 16th and last six weeks. The studies this year will be chemistry, mineralogy, and zoölogy, practical instruction to be given in each, books being employed solely for purposes of reference. The fee for a full course, consisting of any two studies, is $20; for a single study, $12. Neither entrance examination nor recitations will be required.

J. SCOTT BOWERBANK, well known for his studies of the lower forms of marine life, especially the sponges, died at Hastings (England) on the 9th of March, in his eightieth year.

AN observed increase of temperature at the Greenwich Observatory during recent years is attributed, by Mr. H. S. Eaton, President of the London Meteorological Society, to the heat imparted to the air by the city of London. He estimates that the heat developed from the present annual consumption of 5,000,000 tons of coal, on the 118 square miles covered by the city, and from all other artificial sources, would suffice to raise the temperature of a stratum of air 100 feet in depth, resting on that area, 2.5° every hour. On account of this influence, he considers the location a bad one for a first-class observatory.

JOHANN C. POGGENDORFF, for upward of fifty years editor of the *Annalen der Physik und Chemie*, died in Berlin, January 24th, aged eighty years. His scientific studies were mostly concerned with the phenomena of electricity and magnetism. In 1834 he was appointed Professor Extraordinary of Physics in the University of Berlin, which position he held till his death. His contributions to science are chiefly to be found in the "Transactions" of the Berlin Royal Academy of Sciences.

WE learn from the *Milwaukee Sentinel* that the theologians of that locality have arranged a concerted assault upon the conclusions of the biologists, and that paper remarks concerning it, that "the systematic attack arranged by the orthodox preachers of this city on the modern scientific theory of life indicates alarm, and is the first evidence that the evolution theory has met, or is likely to meet, with popular favor." It admonishes them to beware lest they create an interest in the subject, and set people to reading and thinking about it, who, if let alone, would probably pay little attention to it. The chances are that these gentlemen, who have combined to fight biological doctrines from their pulpits, will be the loudest to protest that there is no possible conflict between religion and science.

ACCORDING to an obituary notice in the *Bulletin*, of Baltimore, the late Ross Winans was the first to prove the feasibility of using anthracite coal as fuel on locomotive-engines. He was also the inventor of the eight-wheel railroad-car.

MR. JOHN Y. CULYER, in a recent paper read at a meeting of the Association of School Commissioners and City Superintendents held in Albany, advocates the study of industrial and inventive drawing in our public schools, on the ground that, as a large majority of the pupils in these schools are destined for industrial occupations, their studies should be adapted to improvement in this direction. "Upon what," he asks, "does a man's advancement as a workman depend? Upon three things: his readiness in reading the designs of others, his skill with his tools in fashioning the designs of others, and his skill with his tools in fashioning designs of his own. His greatest advancement comes when he is able to do the latter."

A COMMITTEE of the Ohio College Association has reported in favor of a State Board of Examiners, whose duty it shall be to examine all candidates for college degrees and have the exclusive power of granting the same. This is an important step, and nowhere is such a system more needed than in connection with our medical schools.

THE *Scientific Farmer* states that a factory—the first in this country—for making sugar from corn is now in operation at Davenport, Iowa. The product is known as grape or starch sugar, or glucose, and differs from common or cane sugar in containing more oxygen and hydrogen, and in being less sweet and less crystallizable. It is consumed in large quantities by confectioners, who have hitherto been supplied mainly from France and Germany, where it is manufactured from potatoes.

THE low-lying coast country of the African Continent bears an evil reputation for unhealthiness, and this reputation is, no doubt, in part well deserved. But the habits of the European residents and traders are to blame for no small portion of the excessive mortality. There is a great deal of truth and good sense in the observation of a recent traveler, that even in the deadly atmosphere of the western coast the chances of ill health might be materially reduced, if Europeans would make only a judicious use of stimulants, eat good, well-cooked food, avoid undue exposure to the weather, and shun idleness.

DR. EDWARD RAE, a veteran arctic explorer, complains that the pemmican prepared for the sled-parties of the British Polar Expedition was salted, and that their stores included salt bacon; while the stock of preserved potatoes was insufficient, and condensed milk, an excellent antiscorbutic, was not even thought of. The experience of this expedition goes to show that alcohol furnishes no protection against the effects of excessive cold, but, on the contrary, increases the liability to frost-bite.

FROM interesting statistics concerning suicide in London and New York, given in a late number of the *Lancet*, we learn that self-murder is more frequent in winter than in summer; that, in proportion to population, nearly twice as many kill themselves in New York as in London, the excess being mainly due to the large number of suicides among the Germans; and that drowning, hanging, and cut-throat, are the favorite methods of taking off in London, while poison and the pistol are preferred in New York.

THE Fish Commissioners of Pennsylvania state in their report that the Susquehanna River, from its mouth to the headwaters of both the Juniatas, is now full of black bass. The same may be said of both the West and North Branches for considerable distances above their confluences. The Delaware, too, along the entire State border, is equally supplied, while several of its Pennsylvania branches are filling by degrees.

THE Commission appointed to inquire into the workings of the English Meteorological Department have recommended an increase of nearly one-third in the annual grant for meteorological purposes, and the appointment of a Meteorological Council, to administer the grant in place of the committee of the Royal Society that has heretofore had it in charge.

THE common article beeswax, according to the *American Journal of Pharmacy*, is frequently much adulterated; paraffine, resin, stearine, Japan wax, or mixtures of two or more of these, being the substances usually employed.

ACCORDING to the "Seventh Annual Report of the Fish Commissioners of New Jersey," the yield of fish from the waters of the State was last year much below the average of previous years. This was notably the case with shad-fishing in the Delaware. One of the causes given for this decrease is the introduction of black bass into the river, where they have multiplied immensely, and are believed to devour large numbers of the young shad.

DR. C. W. SIEMENS, President of the Iron and Steel Institute of Great Britain, in his recent inaugural address, strongly urged the necessity for a more extended system of technical education, as the only true basis for national prosperity in the industrial arts. The nations of the Continent of Europe, he declared, were ahead of England in this respect; what little the latter had done having been more a measure of self-defense made necessary by the increasing competition from abroad, rather than the growth of an enlightened public policy, of which the country stands greatly in need.

AN interesting discovery of animal remains was recently made in a cave near Santander, in Northern Spain. The discoverers, Messrs. O'Reilly and Sullivan, describe the cavern as an enlarged joint or rock-fissure, into which the entire carcasses, or else the living animals, had been precipitated. Prof. A. Leith Adams has identified among these remains numerous portions, including teeth, of *Elephas primigenius*, which is important as furnishing the first instance of the occurrence of that animal in Spain.

IF the mirror of a laryngoscope be moistened with glycerine, the water-vapor in the air expired by the subject under examination will not dim its surface, being dissolved in the glycerine. The *Polytechnic Review* points out the benefit to be derived from a similar application of glycerine to the lenses of astronomical telescopes, by preventing the formation on them of dew, which often disturbs observations.

BALFOUR STEWART